15.

AN INVESTIGATION INTO THE SURGICAL PROBLEMS OF INGUINAL, FEMORAL, UMBILICAL, VENTRAL AND CERTAIN OTHER TYPES OF ABDOMINAL HERNIAE WITH A DESCRIPTION OF A NEW PRINCIPLE OF REPAIR USING WHOLE SKIN GRAFTS IN PLACE OF FASCIA.

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I N D E X .

V O L U M E 2.

INTRODUCTION

THE MOTIVE IN WRITING THIS THESIS

The motive in undertaking this task lies in the fact that many problems concerning the etiology, anatomy and treatment of Abdominal Herniae require clarification. The etiology of Inguinal Herniae, and also the anatomy and function of the Inguinal Canal, have often been misunderstood; the treatment of the condition depends largely upon a clear knowledge of these points, and an effort has been made to show that the treatment can be symplified, and comparatively standardised when this has been done.

It is suggested that in the repair of all inguinal herniae the method adopted should depend upon the degree of severity of the condition. If the muscles are powerful, the canal not dilated and the sac small, simple herniotomy is sufficient. Where a repair is indicated the method of choice is fascia. I suggest that a more effective method may lie in the use of whole skin graft implants sutured under maximum tension over the weak points, in order to reinforce the canal and internal ring.

In the case of Femoral Hernia the anatomy of the part is of importance to an understanding of the accepted difficulties of treatment. It is again suggested that there is no need for a variety of methods of repair, but that the whole skin graft approach is applicable to this type of hernia also, and with/

with promise of good results.

The dangers of recurrence in the case of Umbilical Herniae are well known. A consideration of the anatomy and etiology of these herniae is once more essential to an understanding of this problem. In the light of this study it is suggested that the whole skin graft method, reinforcing a classical Mayo repair may offer better prospects of good results than the operations in current use.

Ventral Incisional and Epigastric Herniae are also considered capable of being satisfactorily dealt with by the whole skin method. It is accepted that epigastric cases do not cause so much post operative recurrence as other herniae, but, it is also suggested that it is not an unwise thing to reinforce the conventional type of repair by a whole skin graft, and this especially where the herniae are multiple or large. So far as ventral herniae are concerned the need for fascial repairs is accepted in many of the larger cases. I endeavour to demonstrate that in the use of whole skin grafts inlaid under tension there are advantages overiding those of fascia.

THE SCOPE OF THE THESIS

The first chapter deals with the Historical background of herniae in general, and the second with considerations of those problems which are common to the types of herniae under consideration.

Thereafter each of the five mentioned varieties of hernia is/

is considered in detail from the point of view of anatomy, etiology, progress and complications, symptomatology, diagnosis, differential diagnosis and treatment.

There is a discussion concerning the best method of treatment, and reasons for condemning many commonly used operations are submitted. This is especially applicable to inguinal and femoral cases.

In the light of that discussion an effort is made to demonstrate that where any method of plastic repair is indicated in almost any of these herniae, the best lies in living fascial sutures.

The place which fascia holds is considered and certain adverse qualities which it posesses detailed. It is submitted that there remains room for improvement despite the fact that fascia is an advance over earlier operations.

Then follows an exposition of the properties of whole skin, the normal histological anatomy, and the possible risks which might attend inlay of skin grafts into the abdominal wall. Experimental evidence indicates that whole skin grafts may be sutured under tension to the aponeurosis of the abdominal wall without risk of later complications, and that, in fact, the skin is converted into stout fibrous tissue within which no dermal or epidermal elements can be detected.

The succeeding changes are illustrated by numerous microphotographs taken from sections of skin grafts implanted into rabbits and removed at varying intervals up to nine months/

months after implantation. Certain sections from grafts implanted into the human subject are also illustrated, one from an umbilical repair two years old.

The results of repairs in the human are considered in a series of 500 cases, of which the relative incidence of the various types of herniae are as follows:

Inguinal	438
Femoral	20
Umbilical	18
Epigastric	7
Ventral	17
Total	500

The results of the treatment of inguinal herniae are considered with especial care. The series of 438 inguinal cases were treated along the following lines, viz.

Herniotomies.
Herniotomy plus Bassini repair.
Herniotomy plus living fascial graft repair.
Herniotomy plus whole skin repair.

The cases were almost all followed up, and conclusions as to recurrence are based upon a follow up of not less than one year. Immediate post operative morbidity is compiled from a total of ~~454~~ 438 operations, and late post operative morbidity from a total of 237 follow up examinations.

The results of the various methods of treatment are compared with one another, and with those from other clinics. The results of the whole skin graft method are compared with those from other clinics using other methods. The morbidity rate, both early and late, is compared with that for other types of repair in my own series, and with figures from other clinics.

Illustrations are submitted to demonstrate operative technique in the use of whole skin grafts and fascial grafts in the repair of various types of herniae.

The treatment of complications is described and, especially in strangulation it is emphasised that this must be conservative. The causes of strangulation are reviewed.

The place of other types of treatment in herniae generally is discussed, especially the injection method, the truss, floss silk and filigree wire.

From the point of view of the medical jurist, workman's compensation and general incidence in the community the subject is considered and it is emphasised that early operation saves lives, gives better results, saves employers money, and improves the general health of the patients.

A review of the various better known methods of dealing with the repair of inguinal and femoral herniae is appended, and finally a table of the inguinal cases in my series.

LIMITATIONS OF THIS THESIS

The number of epigastric, umbilical, femoral and ventral cases in my series is not sufficiently large to dogmatise upon results, and, in the inguinal series many more than a hundred and fifty would be required to reach absolute decisions as to the efficiency of the Whole Skin method. I suggest however, that the series is large enough to justify coming to certain tentative conclusions.

CONCLUSIONS REACHED IN CONSEQUENCE OF THE RESEARCH

Certain important Anatomical Facts are exposed which have a relationship to the etiology of inguinal herniae. These are: the frequent abnormal insertion of the conjoined tendon into the rectus sheath rather than the pubic tubercle: the relaxation of the conjoined tendon and fascia transversalis when the thighs are flexed, abducted and externally rotated in the position frequently adopted by manual workers in pushing or lifting heavy loads: the fact that the iliohypogastric and ilioinguinal nerves are sensory in the area exposed at operation for inguinal hernia, but liable to be damaged in their motor fibres during removal of an appendix by a grid iron incision: and finally the arrangement of the muscle fibres as a sphincter at the internal ring.

The importance of the linea alba is stressed in Ventral and Umbilical Herniae and the tendency for it to be affected by the lateral pull of the anterolateral abdominal muscles, emphasised as dominating the subject of repair.

The Function of the conjoined tendon and internal muscular ring as a sphincter is determined, and considered to be of high importance to the prevention and repair of inguinal indirect herniae. Conclusions are reached as to the types of strain which lead to the development of hernial sacs in the inguinal canal, both direct and indirect.

It is concluded, so far as Treatment is concerned, that too/

too many operations for hernial repair have been devised, and that the operative treatment can be simplified. This scheme is concluded to be adequate for those herniae under consideration.

INGUINAL
1 Indirect
(a) Herniotomy; or
(b) Herniotomy plus buttressing of fascia transversalis; or
(c) Herniotomy plus fascial graft; or
(d) Herniotomy plus whole skin graft.

2 Direct
(a) Whole skin graft; or
(b) Fascial graft.

FEMORAL
(a) Removal of sac plus whole skin graft.

UMBILICAL
(a) Removal of sac, Mayo repair, Whole skin graft inlay to conclude operation.

EPIGASTRIC
(a) Removal of sac and repair of linea alba; or
(b) Removal sac, closure of defect in linea alba and whole skin graft repair.

VENTRAL
(a) Removal of sac, reconstitution of the wound; or
(b) Removal of sac, reconstitution of wound and final reinforcing by whole skin graft.

IDEA WHICH LEAD TO THE RESEARCH BEING PERFORMED

Consideration of the recurrence rates for Herniae as a whole impressed me with the realisation that something remained to be done to improve upon the best methods of plastic repair available, namely living fascial grafts.

A substitute for fascia which would give better results, lack the disadvantages of fascia, be easy to perform and applicable/

applicable to any case was sought. Whole skin was finally selected as a possible solution and a full investigation into its properties commenced. These were such that the principle was applied to the practical treatment of Herniae in the human subject, and with the results to be described.

In order to render the Thesis comprehensive it has been necessary to describe matter which is known and shows no originality, noteable the symptomatology, certain aspects of the anatomy, and of course the legal problems of the subject. The gathering and consideration of even these points may have value and do, in any event, have a bearing upon many other aspects of the subject. A consideration of the whole hernia problem is essential to an understanding of isolated parts of it.

All references in the Bibliography have been personally verified.

The work was performed in the wards and theatres of Old-mill and Woodend Emergency Hospitals. Animal experiments were carried out in the laboratories of Aberdeen City Hospital.

References were obtained from the libraries of The Royal Society of Medicine, The British Medical Association, Aberdeen Royal Infirmary, Lewis' Lending library London, Aberdeen City Hospital and The Royal College of Surgeons Edinburgh.

CHAPTER I

HISTORICAL REVIEW OF THE TREATMENT OF INGUINAL HERNIAE

In the Wellcome Historical Museum [1.] there is a statue of an Egyptian Mummy wearing a truss - a testimony to the antiquity of inguinal herniae, and to the fact that over many centuries, at least one method of treatment has remained substantially unchanged. From very earliest times of recorded history, Man has struggled with the problems of cure in herniae, and, in later days the stream of literature has been so vast as nearly to defy full examination by any ordinary worker who has to take count of the exigincies of time. Herniae, were, in fact, amongst the first conditions dealt with by the primitive surgeons of by gone days.

The earliest historic records of surgery began with the Sumerians in Mesopotamia (about 4000 B.C.). Their knowledge was scanty and tinged with the cults and superstitions of their times, but the seeds of knowledge were sewn and from them were to erupt in more enlightened days great trees of achievement. These primitive peoples were overwhelmed by the Babylonians and Assyrians, who each added something, of value or otherwise, to the development of Medicine.

The Babylonians were enthusiastic Astrologers, and so that science came to exert a great influence over Medical practice in all its aspects. The anatomical anas of the

body/

body were each placed under a sign of the Zodiac and Medicine became obscured by a worship of Astronomy and Astrology to the detriment of progress.

The earliest written rules concerning surgical practice are found in the Code of Hammurabi (2200 B.C.), in which it is stated: "If a physician cause a severe operating wound with a bronze operation knife and cure the patient, or if he open a tumor and save his eye, he shall have ten shekels of silver." By way of stimulating efficiency, if the patient died, the physician had his hands amputated.

When a person was ill, it was the custom of the Babylonians to lay him in a public place where passers-by could converse with him, and if they had ever had his disease or knew of any one who had suffered from it, gave advice as to procedure.

But the Babylonian Empire later came under the dominance of Egypt, where, about 2000 B.C., the Arts of Medicine and Surgery reached their zenith. The Egyptians improved upon the surgery of the Babylonians. Bronze knives, came into use, surgeons experimented with knots, and abscesses were opened and packed with lint, or other substances impregnated with antiseptics. They also advanced the treatment of hernia, and excelled over early Nations in the practice and development of hygene.

The priests were the only physicians, and medicine was taught in the temples. They beleived that strangulation of hernia/

hernia, which they recognised, was due to an accumulation of hardened faeces in the bowel. This was also a belief of the ancient Jews, which is mentioned in the Old Testament, and was held later by Celsus and by most surgeons after him, until Lavater [2.], in the seventeenth century finally dispelled it.

Most of our knowledge of the medicine and surgery of ancient Egypt is derived from the Ebers and Smith papyri, B.C. 1550 and 1660 respectively. There, hints as to the treatment of hernia are given, but nothing in detail. The first comparatively full accounts are derived from the Greeks who, at a later period contributed much to Medical progress and excelled especially in Diagnosis.

Of the Greek Schools, that of Hippocrates, who lived in the fourth century B.C. and was a descendant of Aesculapius, was the most outstanding.

Hippocrates collected the available knowledge of his times on disease and its treatment, and added to it from his own genius, observation and experience. In his writings, as well as in the fragments left by his contemporaries, Praxagoras of Cos and Coelius Aurelianus, there are references to hernia. Praxogoras is credited with treating strangulated hernia by reduction by taxis.

Galen, the last of the famous Greek surgeons, lived in the second century A.D. He studied in Alexandria and afterward went to Rome. Galen's method of treating hernia was generally by ligating the sac at the external ring or below it./

it. His belief that hernia was due to a peritoneal rupture was held by many, throughout succeeding years, but in the opinion of Paulus AEginata and those who followed him, many hernias of slow formation were due to stretching of the peritoneum, and only in cases of sudden onset was the peritoneum ruptured. Rhazes [3]. Lanfranc, and Guy de Chauliac, who came later, apparently knew that in hernia there was no peritoneal rupture, but the point was not fully established until proven by Ruysch's dissections at the end of the seventeenth century.[4].

Of the very earliest treatises on hernia that of Celsus is undoubtedly best. It reveals a knowledge both comprehensive and useful, but demonstrates the limitations of surgery of the times. Celsus lived in the latter part of the Augustine period and on in to the reign of Tiberius though he probably acquired much of his knowledge from the Greeks, as it is well known that Rome took over Greek Medicine and Surgery fully developed and added nothing to it.

From his writings it is evident that Herniae demanded attention more from the cosmetic view point than the practical. The Roman Cult of Nudism rendered any unfortunate who presented a swelling open to ridicule, and the very term "hernia" derives from the vulgar Roman expression of the day for an ugly swelling or lump. Its frequent locus was the more unfortunate, as Roman Genitalia were a subject of pride and not for scorn. This excessive pride in the genitals is revealed by the detail in sculpture shown by artists of the times/

times, and the fact that statues do exist where only the bust and genitals are carved and supported by a pedistal.

Celsus in his surgical treatise, laid down the importance of removal of the sac, indicated that best results are found when the swelling is not large, showed a keenness for operation on children, described in detail the anatomy of the inguinal canal, and expressed the opinion that the condition there owed its origin to a deficiency of the oblique muscles. He also described the fascial layers, especially the cremasteric and dartos fascia, noted the risk of post operative haematoma when the testicle is removed from the scrotum, and suggested the advisability of inserting a drain to the lower pole of the scrotum when haematoma seemed probable. He also indicated that in large herniae, good results may be had following upon development of much scar tissue, and advocated excision of skin and muscle to achieve this end.

He has also described several types of sac, with their contents, indicated how the contents may be diagnosed before operation and dealt with at operation when they are irreducible.

In short, it is astonishing that during the 1800 years which followed his death so little was done to advance treatment in the light of the known knowledge of his times.

The Phoenicians [5.6.7.8.] advised the use of girdles to support the swelling, and compresses of herbs and ointments to soothe the pain of strangulation.

Heliodorus in the second century, A.D.,removed the freed sac. This was a formidable operation, and few sufferers were likely to submit to it unless strangulation had set in. It may be assumed that the results were deadly. Even in the Sixteenth Century, Ambrose Pare, using the same technique, was shocked by the death rate.

By about A.D. 500 the Persians had taken over most of the Greek knowledge, but they in turn passed it on to the conquering Arabs. The period of Arabic ascent began with the second destruction of the Alexandrian school in 640 by Omar, successor to Mahomet. The Arabs produced many noted scientists and mathematicians. Among the famous Arabian surgeons may be mentioned Rhazes [3.] (850-932), who described the suturing of wounds with the strings of a harp; Haly Abbas (994), who operated extensively for hernia; Avicenna (980-1037), who described the differential diagnosis of enterocele and omentocele by auscultation; and Albucasis (1122), who closely followed the methods of Celsus. Terapion, Avicenna and Albucasis treated hernia by cauterization after exposing the sac by incision. [4.] It can thus be seen that the Arab contribution to the surgery of abdominal hernia was considerable.

During the eleventh century, leadership passed from the Arabs to other races in Europe. Schools were established in different countries, and medical teaching actively revived. Salerno and Montpellier were amongst the earliest and most famous of these early Medical Schools, and reached the height of/

of their influence during the twelfth and thirteenth centuries. Others sprang up elsewhere, notably in Bologna, Padua, Paris, Naples, Toulouse, Valencia, and Oxford, and for long influenced Medical progress, in some cases up to the present time.

During this period, in the twelfth and thirteenth Centuries, Medicine and Religion were closely associated. In Italy and France nearly all the surgeons were priests, and surgery was not recognized as a separate craft by the authorities until later. Throughout these years all varieties of charlatans were to be found - "hernialists," cutters for stone, bleeders, and so on, who with the possible exception of the bleeders, usually did more harm than good.

Samuel Papys [14.] in his diary, notes the habits of itinerant "rupture curers" who travelled the country after the fashion of their colleagues who "cut for the stone," but himself did not fall into their hands.

Then in the fourteenth century arose an expert in surgery, Guy de Chauliac. He was primarily an anatomist, and the first to distinguish umbilical from inguinal and femoral hernias, his life marks an important mile stone in the operative treatment of these conditions.

The Age of the Renaissance showed phenomenal progress in all arts and sciences. Among the notable events in the history of hernia are Pol's report of the first case of hernia of the uterus. Pare described diaphragmatic hernia; Fabricius Hildanus wrote on partial enterocele, and Roussetus described the operation for strangulated hernia, which was later improved and popularized by Pierre France.[4.]

Two hundred years later came an awakening in the study of anatomy and surgery, and a final breaking away from the beliefs and practices, superstitions and prejudices of other Ages.

De Garengeoc, almost a contemporary of Pare, the famous Frenchman, was the first to attempt a method of repair, and chose to use the sac, freeing same and rolling it into a pad which was sutured into the inguinal canal.

Knyveton [9.] describes in his diary a cure of strangulation by incision of the sac and incarcerated colon with creation of a faecal fistula and later, spontaneous cure.

Wutzer in 1840 [10.11.] made use of setons, and, in 1844 Pancoastin [12.] injected into the inguinal canal dilutions of iodine to the opened sac, whilst in 1877, Heaton recommended injection of 70% alcohol. It is suggested, however, that the first exponent of injection therapy was a Frenchman, Desault [13.] who introduced red wine into the scrotum.

The fashion for injection treatment during the 18th and 19th centuries arose from the bad results of practical surgery, but is now enjoying a new vogue, and that through the work of Mayer, Jameson and Cantala, in America, plus the high incidence of recurrence after operation even in the best known surgical units.

In 1881, March [15.16.] a pupil of Lister, argued that delay in repairing the condition was responsible for the unsatisfactory results of the operations, and advocated high ligation/

ligation of the sac with transposition of the cord plus repair of the canal. He is reputed to be the first surgeon to practice a plastic repair, if one excepts the early efforts of De Garengeoc. He urged the use of kangaroo tendon. His results however, whilst constituting an advance, left much to be desired. Sepsis was a frequent complication.

In 1886, MacEwan utilised the rolled up sac to plug the internal ring and from then on, never ceased to be interested in this problem of repair, and to build up a reputation which, with Bassini and Halsted will always be associated with the evolution of the surgery of herniae. MacEwan's first contribution however, in which he drew attention to the importance of narrowing the internal ring seems to be in 1880. [17.]

Three years later Bassini [18.19.] in Italy, and Halsted in America, at almost the same times published their respective accounts of their operations which, though differing in detail, were substantially the same in essentials. The fundamental step of the Bassini operation was and is, high ligation of the sac with suture of the internal oblique muscle, to the inguinal ligament.

Halsted's first steps were the same, but he repaired the canal by bringing the spermatic cord superficial to the aponeurosis of the external oblique. Shortly, however, he modified the operation till it closely resembled a Bassini, and finally he utilised the anterior sheath of the rectus. Constantly, like Bassini he emphasised the absolute necessity of high ligation and excision of the sac.

To the present day, whilst these operations remain the basis of most repairs, much time has been devoted to considering wherein they could be improved, and a host of modifications have been evolved.

McArthur [20.] in 1901 was the first to write the story of attempts to utilise living sutures and cut his material from the external oblique aponeurosis. Yet, even he had not found a solution to please all. Recurrences were still far too frequent, and in 1910 Kirschner [21.] advocated the use of a flap of fascia lata to overlap sutures applied deeply after the fashion of Bassini. The third and final important contribution to this method was given eleven years later by Gallie and LeMesurier [22.] who cut narrow strips of fascia from the fascia lata of the thigh and sutured them between the conjoined tendon and inguinal ligament by means of special needles. A modification of the principle was contributed by Wangensteen[23.] in 1934 with the suggestion that the ilio-tibial tract be utilised as a pedicle graft. This has found but little favour, and in any event is fundamentally unnecessary as vascularisation of the living fascial sutures occurs within three weeks, the attachment to surroundings is firm and secure.

Until lately, the tendency was to reserve fascial sutures only for very large types of herniae, but within the past few years opinion has altered in favour of its use for any case requiring repair until the final dictum to that effect lately pronounced by Edwards in October, 1943.

During all Man's struggles with herniae, and it is an outstanding example of enterprise and energy, there have been at least four methods clearly defined, and, throughout the past century, all have been in practice. The first, injection of sclerosing fluids into the inguinal canal to produce an aseptic inflammation with later fibrosis and narrowing of the passage. Secondly, the use of supports and trusses. Thirdly, the removal of the sac without any attempt at repair, and finally, removal of the sac with some form of repair to complete the operation.

These are the four methods of attack available at the present day.

During the past ten years, in America, Koontz [24]. Cooksey and Rosenblatt [25]., and Meyers [26]. have extensively investigated the question of the possibility of union taking place when muscle is sutured to fascia or tendon as in the Bassini and Halsted operations. Their findings are strangely conflicting, but the balance of the evidence, especially when taken into conjunction with that from other investigators, suggests that union may take place under such circumstances, but very frequently does not, and that, moreover, when it does take place it is of poor quality and liable to be followed by stretching of the uniting scar tissue. This is the crux of the matter as regards the rationale of the two procedures mentioned. It is suggested further that not only are such methods of repair inefficient, but actually harmful, as the tension on the/

the sutures leads to atrophy of muscle fibres, and an increase in the defect which is present in the structure of the posterior wall of the canal with resulting increase in liability to the development of a direct hernia. But the work of these American Surgeons is of high importance, and serves as a firm and scientific basis of discussion as to the advisability of such operations being further perpetuated. This is dealt with in a later chapter, but is introduced here as an important step in the history of the surgical approach to the problem of cure in inguinal hernia.

Amongst the many modifications of the Bassini repair are those associated with the names of Fowler, Ferguson, Andrews, Torek, Blookgood, and many others. Their contributions will be considered at the appropriate time, but only to be condemned. Within the last decade, the question has arisen as to the advisability of applying individualism to hernia repair as opposed to the routine use of a standard procedure. The answer to this would seem so obvious that one marvels the question has been so earnestly discussed. There can be no doubt surely, in the mind of anyone who has practised hernia repairs, that each case must be assessed on its merits at operation, and that only then can the exact method most ideal to the particular case be decided upon. But this choice of operation must be limited, and not as at present - the selection of one from a wide number.

A book could be written about the history of the treatment of hernia, and thousands of pages have, in fact been written throughout the years, but now we are approaching satisfaction. One agrees with Edwards that a study of this history is commended to all who have been or may be persuaded into designing and perfecting a new method of cure for this age-old deformity. One agrees further than this study serves to emphasise that there are already too many operations to hand, and that improvement will come not from the evolution of more, but from the careful attention to technique, pre and post operative care, selection of optimum repair for each case and increase in technical skill of the operator. Despite that however, I believe that with the practice of the whole skin method, which will be considered in due course, a technique has been suggested, which, if it fulfils its initial promise, will be a useful contribution, and capable even of supplanting, to a degree at least, fascia, in certain types of case.

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CHAPTER II

GENERAL OBSERVATIONS CONCERNING ABDOMINAL HERNIAE

Definition

An abdominal hernia is a protrusion of an abdominal viscus within a sac of peritoneum through the abdominal wall. The term "rupture" has been frequently used by lay people to describe the condition, but is inaccurate, as it implies tearing of the abdominal wall or peritoneum, and this is not usually the case. In the specific instance of hernia following upon severe physical trauma associated with damage to the abdominal wall it may be justifiable, but, for the most part should be discarded.

Nomenclature

Abdominal Herniae are designated according to their contents, locus, etiology and condition.

1. According to Contents of the Sac

According to contents of the sac such as hernia of the small intestine, hernia of the omentum, hernia of the large intestine, of the bladder and so on.

2. According to their Locus

The hernia may be inguinal, direct or indirect, femoral, umbilical, epigastric, ventral, etc.

3. According to their Etiology

They may be described as congenital, acquired, traumatic or recurrent post operative.

4. Descriptive of their Condition

Descriptive of their condition, are the expressions, reducible, incarcerated, obstructed, inflamed, strangulated and gangrenous.

ANATOMY OF A HERNIA

A hernia is composed of a sac, its coverings and its contents. It also has certain relationships to the surrounding tissues, which may deviate from normal in long standing or large cases. Each of these must be considered from the point of view of treatment, etiology, and complications which may affect them.

The Hernial Sac

All sacs can be subdivided into those which are congenital or present from birth, and those which are acquired later in life consequent upon other factors.

Congenital or Preformed Sacs

For many years there was considerable diversity of opinion as to whether or not the average hernia was potentially present from birth owing to the existance of a preformed sac. Formerly it was customary to classify herniae into congenital types which appeared at or shortly after birth, and those acquired varieties which developed in later life.

The work of Hamilton Russell and his associates, together with researches by Keith, Bannerjee and others has proven without doubt that many people possess an unobliterated, or partially/

partially obliterated processus vaginalis from birth and yet may not acquire obvious herniae. It is also now accepted that the existance of this preformed sac is important to the development of inguinal hernia in adults, though other factors must also be concerned, as, every subject possessed of a preformed sac, does not of necessity acquire a hernia. There may also be a congenital sac associated with umbilical and certain forms of ventral hernia, possibly also in femorals.

The average sac can be anatomically divided into four parts, mouth, the neck, body and fundus. Fig. I The mouth is that portion which communicates at the neck, between the abdomen and the interior of the sac.

The neck is that constricted part at the point of emergence of the peritoneum from its normal confines within the abdomen.

In certain types, for example, diffuse direct inguinal or ventral sacs, the neck may be practically non existant, and the mouth a gaping defect in the abdominal wall. In indirect varieties, however, the neck is readily identifiable and leads on to the body distally.

The body comprises the larger portion of the sac and may assume large dimensions. It may contain almost any abdominal viscus and lies in relation to the structures of the abdominal wall. In large cases the greater area of the sac may be outwith the limits of the abdominal wall and depend into the scrotum stretching it and hanging almost to the knees.

The fundus or the arching curved extremity of the body

is/

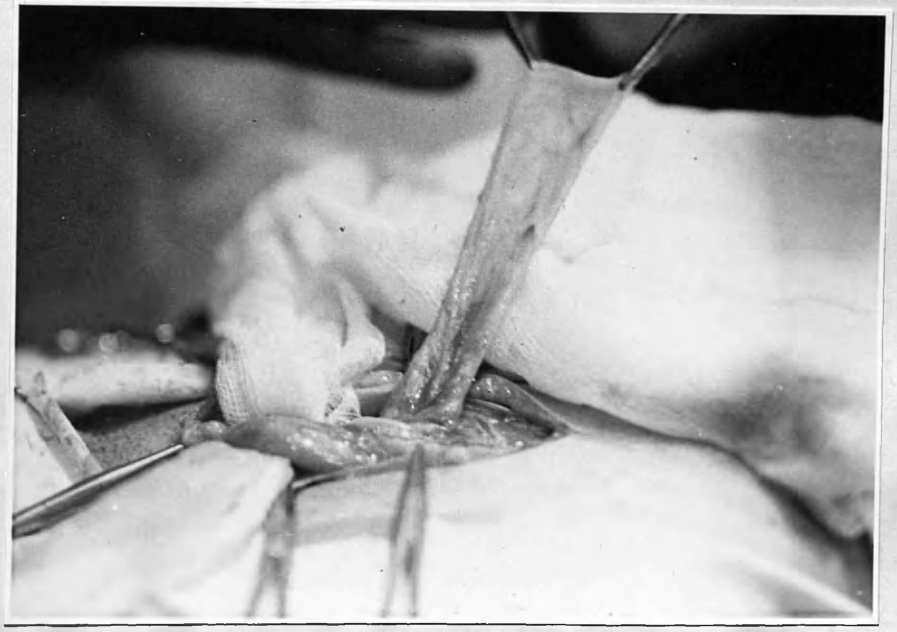


FIGURE I

A TYPICAL HERNIAL SAC

is the most distal part of the sac. It is that portion which is generally sought for at operation in small cases when the white gleaming curve of the fundus may be a landmark of value. It may be very large in umbilical and ventral cases.

If the sac does not pass the abdominal external ring it forms when distended, a soft swelling over the inguinal canal known as a bubonocele, Fig. 2; should however, it pass the external ring it occupies the upper part of the scrotum and assumes an ovoid form. Fig. 3. It consists of a layer of parietal peritoneum which, in an uncomplicated case may be smoothe and glistening, but, frequently exhibits evidence of inflammation being then thickened and fibrous, and possibly adherent to both coverings and contents, this is especially so in umbilical varieties.

The sac need not necessarily be occupied, and in congenital types may for years lie empty. Even when contents are present they can usually, in early cases, be speedily returned to the abdominal cavity by simple manipulation or change in posture. They are at first forced into the sac by any strain, which increases the intra abdominal pressure. The neck and mouth are then stretched. If the contents later are returned to their normal locus, that is to say "reduced" the effects of this stretching persist and the process is readily repeated. With each repetition the mouth becomes more dilated, and, in large cases may become sufficiently wide to admit the passage of several fingers.

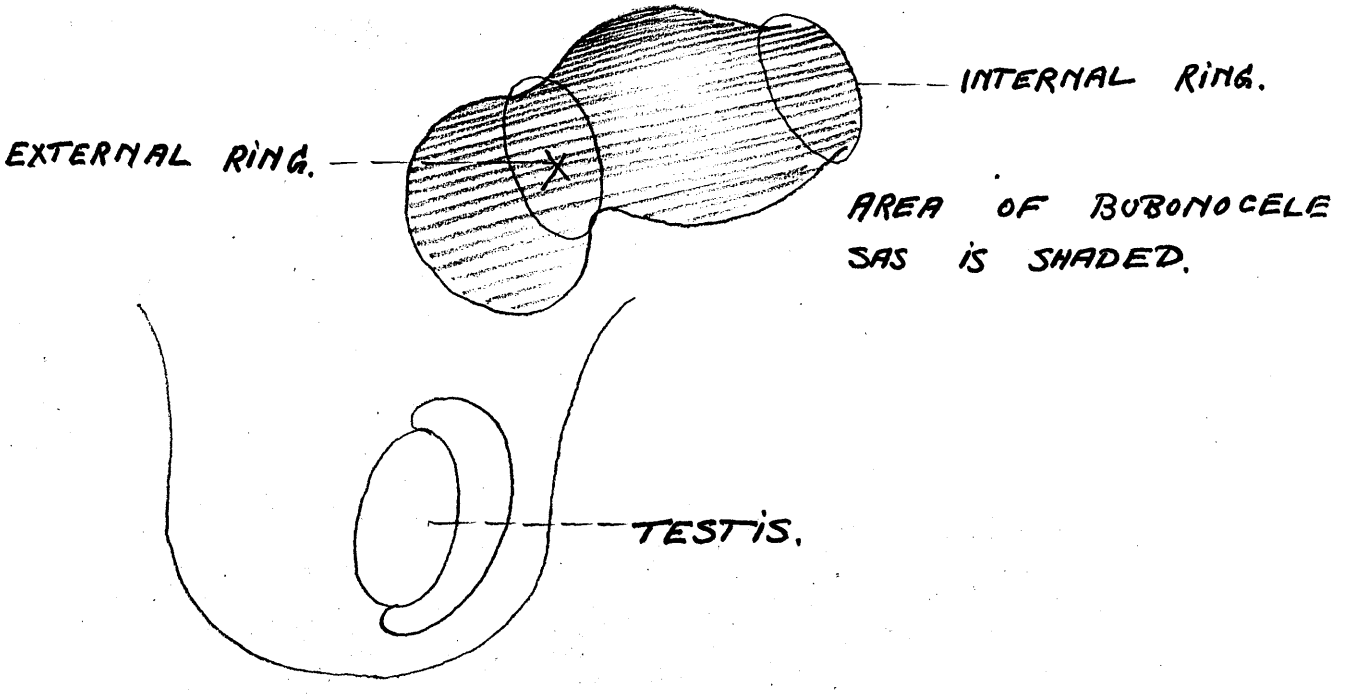


FIGURE 2

TYPICAL BUBONOCELE

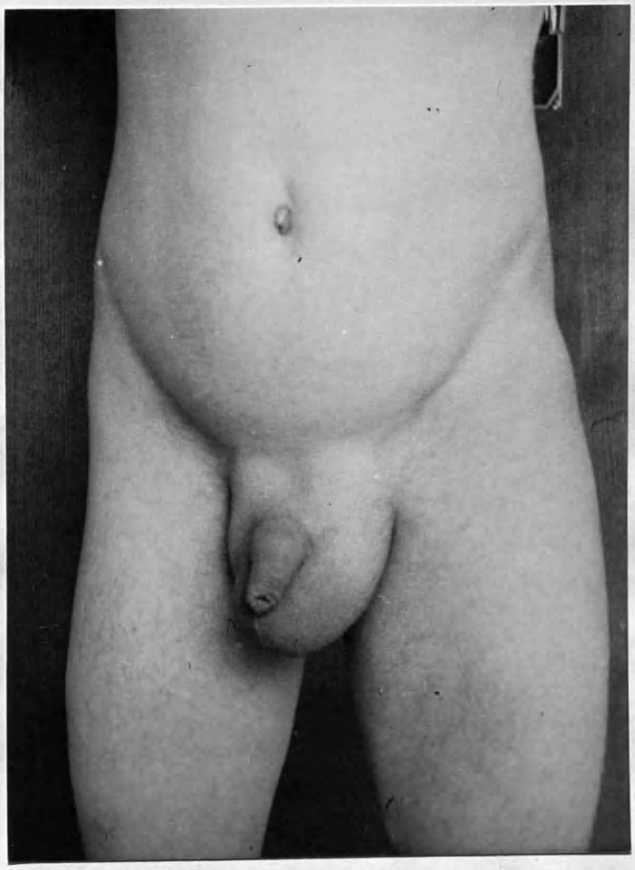


FIGURE 3

SCROTAL HERNIA

Similarly the body is enlarged, and eventually may be able to accommodate most of the intestinal tract between the duodennal jejunnal flexure and pelvirectal junction.

In the particular variety known as "sliding hernia" or "hernia en glissade," the sac may be incomplete and the related viscus partly outwith it. This is not very common, and when present the organ involved generally bladder, caecum or descending colon. It applies particularly to the inguinal region.

Acquired Sacs

These were not present at birth but owe their development to repeated minor, or major strains imposed upon the abdominal muscles. These are gradually rendered sufficiently incompetent to permit the extrusion of a small portion of parietal peritoneum through a weak area in the abdominal wall. The sac consists of stretched parietal peritoneum.

Acquired sacs are subject to exactly the same complications and pathology as the congenital types. Direct sacs are invariably acquired and characterised by being small with a relatively large mouth. They are almost always globular owing to the shortness of the neck and in the inguinal region generally remained confined to the canal. A direct inguinal sac, can however, be funicular and possess a narrow mouth and identifible neck with attenuated body. This is less common.

Shape of the Sac

Sacs vary greatly in shape and size, depending upon the site/

site of the hernia, the nature of the coverings and surroundings, the size of the mouth and neck, the presence of irritation inside or outside the structure, and line which it is obliged anatomically to follow with increase in size.

It may become constricted or hour glass shaped by adhesions within, or acquire loculations within for the same reason.

Relation of the Sac to other Structures

The indirect inguinal sac emerges through the abdominal wall at the internal ring, passes through the canal and may emerge at the external ring to enter the scrotum.

It thus relates to the structures forming, and to the contents of, the inguinal canal. It is almost always anterior to the spermatic cord but may be posterior.

The direct sac emerges through the abdominal wall somewhere in the posterior aspect of the inguinal canal, and often by way of a rent in the fascia transversalis. Its coverings therefor differ from those of the indirect variety, but, as the neck is wide there is little risk of compression of the contents and strangulation is unusual.

The spermatic cord is only loosely attached to a direct sac. An umbilical hernia in children appears as a small spherical mass in relation to the umbilicus and rendered prominent when the child strains. It eventually flattens the umbilicus and becomes conical.

In adults it appears lateral to, or above the umbilicus but later, with increase in size depends over the lower anterior abdominal wall. Femoral sacs lie in relation to the soft tissues of the upper thigh medial to, or overlying the great vessels in Scarpa's triangle. They are frequently embedded within this fatty mass.

Sacs of ventral herniae may be of any size or shape, but relate to the structures of the abdominal wall.

Bilocular Sacs

Rarely the sac may be duplicated, both sections sharing a common mouth into the peritoneal cavity. This is rare however, and should be distinguished from proparietal and interparietal and other similar varieties. Occasionally one section may lie in relation to the femoral canal and the other to the inguinal.

The condition has been discussed by Schrager [39].

Contents of the Sac

Almost every abdominal organ has been found within a hernia, but the most common are omentum, small intestine, sigmoid colon, caecum, appendix, other parts of the large bowel, the bladder and uterus with adnexae. Liver and spleen, stomach and kidney have all been described, though rarely.

The omentum may enter whilst the mouth is yet narrow, and rapidly forms adhesions. These are almost constant in umbilical sacs. Fig. 4. It has long been recognised that when intestine/

intestine is present omentum is frequently in advance of it. Thus when applying taxis for reduction of the condition the proximal portion of the swelling should first be reduced as these omental adhesions may render the omentum irreducible. Fortunately adhesions less frequently form between the omentum and other viscera, though when present may cause one form of internal strangulation. Should a portion of intestine remain within the sac for any length of time its wall exhibits certain changes. The serous coat becomes thickened and rougher than that of abdominal intestine, the mesentery increases in length as the viscus depends further into the sac, and the walls may show periods of congestion if there is temporary interference with the blood supply.

Foreign Bodies within the Sac

Often small fibrinous bodies may be located which vary in number from a solitary nodule possibly attaching to the sac wall, up to a collection of small seed like structures of varying size and number. These may originate from lipomata which have become calcified or fibrosed. Lipomata in all stages of fibrous and calcareous infiltration are also seen. Rarely foreign bodies such as pins or tacks, portions of metal and the like may be present having ulcerated through the gut wall, though rarely in the uncomplicated case.

Special Types of Content

A Meckel's diverticulum may sometimes be found. This is known as a Littre's Hernia. When only a small portion

of/

of the circumference of the intestinal wall is contained, the condition is described as a partial enterocele or Richter's Hernia. This is potentially dangerous as it need not be detectable on external examination. Strangulation when it takes place may, therefore, not be suspected and diagnosis not made until too late.

DISEASES OF THE HERNIAL SAC

Tuberculosis The sac may show evidence of tuberculosis, but this rarely if ever confined to the sac, and is almost always but a part of a generalised tuberculous peritonitis.

Jonnesco [40.] and Lejars [41.] maintained that primary hernial tuberculosis could and did occur, but the general view is that it is usually if not always, due to a downward extension of abdominal peritoneal tuberculosis. [42.] The condition is most frequent in the inguinal variety.

Symptoms The condition is often painful. The pain is severe and continuous, is limited to the hernia and rarely referred elsewhere. The hernia tends to increase in size and to become irreducible.

The usual general manifestations of tuberculous toxaemia are apparant.

Adrenal Rests Portions of tissue derived from the adrenal glands, and known as adrenal "rests" have been described. These are small, embedded in the wall, often multiple and of no pathological significance.

FIGURE 4

INTERIOR OF UMBILICAL SAC
WITH ADHESIONS

DISEASES OF THE CONTENTS

The contents may be affected by any disease peculiar to the viscus concerned. Acute inflammation may be associated with hernia containing the appendix. Neoplasms may be present in the large bowel. [2.] Regional ileitis may rarely complicate an enterocele, but the most common conditions are probably tuberculosis and acute inflammation. Echinococcal cysts are found abroad, and other larvae may also be present, for example Paragonimus westermanii. [1.]

ETIOLOGY OF HERNIA

The various factors concerned may be considered as predisposing and precipitating. Of the former may be listed the presence of a congenital sac, obesity, age, sex, certain diseases such as chronic bronchitis, and certain anatomical abnormalities or peculiarities of the anterior abdominal wall. Of these, the most important are the precise insertion of the conjoined tendon into the pubis or rectus sheath, the integrity or otherwise of the fascia transversalis, the presence of an undescended testicle, and normal habitus of the individual, asthenic, sthenic or hypersthenic, and deficiencies in the linea alba or umbilicus.

Of the exciting causes, strains of various kinds are most important. The nature of these strains vary from accidents at work to repeated pregnancies.

Normally the inguinal canal is a valvular structure capable of maintaining the integrity of the abdominal wall in that part. Certain strains may lead to the efficiency of this valvular mechanism being reduced, and this is especially liable to occur in the presence of various anatomical abnormalities.

Heredity

Statistics show that 25% of patients give a history of hernia in parents or grandparents [3], but, in my series of 450 cases only 9% gave a family history.

Age

This is an uncertain etiological factor but the incidence of hernia shows two peak periods, the first in the first year of life. From then on the condition diminishes in frequency until adolescence when it again rises and remains high during the period of active working life until fifty. Thereafter the indicence progressively falls. In old age it is uncommon, though it is common to find old people who have suffered from hernia for many years. Its primary development is uncommon in the aged.

The direct type is uncommon in childhood. Femoral hernia occurs at a slightly earlier age on the average, amongst women than men.

Sex

Of 2994 men aged between 43-51 examined in the Manchester and Stockport area 12.5% showed herniae, whilst of 10000 young/

young men in Scotland drawn from a mixed rural and urban area, and between the age of 18 and 41, 3.6% were the subjects of hernia. [38.]

Inguinal hernia is much more frequent among men than women, and in my series 4 % only were in females. Of 21795 cases collected by Macready [4.] 84% were in males, and in 70090 observed by Coley [5.] 75.7% were in males. The reasons for this derive from two main factors, the differing anatomy of the inguinal canals in the two sexes, and the increased incidence of strains of various kinds imposed upon the male workman. Armentrout [6.] reported upon the examination of 37472 manual workers and detected hernia in 1837. Berger, quoted by Watson [3.], estimated that one male in 14.9 had a hernia whilst only one female in 44.7 exhibited the condition.

Femoral hernia occurs in the proportion of three females to every male. In my series of 20 femoral hernias the proportion was five to one.

Obesity

Accumulation of fat in the abdominal wall, and fatty infiltration of muscles leads to muscle weakness with later incompetence. Secondly, deposits of fat in and around the mesentery increase intra abdominal tension. The two factors together may lead to the development of hernia, and especially at the umbilicus.

Pregnancy

Pregnancies/

Pregnancies judiciously spaced will not lead to muscular incompetence, but often repeated, the condition may be of some importance in leading to weakness of the abdominal muscles.

Intra abdominal diseases

Any condition which leads to increased intra abdominal tension together with muscular weakness may be followed by a hernia. Of these various conditions, ascites, splenic enlargement, large cysts, neoplasms, and enlargement of the liver are important.

Constipation and prostatic disease in men may cause hernia by oft repeated straining.

Length of Mesentery

Under ordinary circumstances the length of the mesentery would prevent a loop of bowel reaching to the scrotum. When such has taken place it is not due to a naturally long mesentery, but rather to progressive lengthening of the structure in a chronic case. It is improbable that the length of the mesentery is a factor of consequence in the primary development of any type of hernia.

Trauma

Severe physical trauma may occasionally, by rupture of the abdominal musculature and laceration of fascia or peritoneum, lead to the immediate development of a hernia. This is infrequent, but important in relation to workman's compensation.

SYMPTOMS AND SIGNS OF HERNIA

The symptoms and signs vary with the type and condition of the hernia. Certain of these are common to all cases.

(1) REDUCIBLE HERNIA

Here the contents can be returned to the abdominal cavity.

Symptoms

The patient usually complains of some weakness in the hernial site and may at first experience pain located over it. Thereafter he becomes aware of a swelling which is soft, and reducible by manipulation or by lying down. A considerable time interval may elapse before the swelling is sufficiently large to attract attention, and it may be symptomless from the beginning.

There may be a history of strain, whooping cough in children, chronic or acute cough in adults, or strain whilst at work. In a considerable number of cases no cause can be found and the patient is aware of nothing to account for the small swelling of which he complains.

When the hernia is "down" there is often a sense of weight in the part, or even pain, but, in an established case pain is not usually present in the absence of complications. Pain is usually most severe when the hernia is small.

Reflex digestive disturbances may be observed, and pain located in the hypogastrium or epigastrium which is aggravated by exercise and releived by lying down.

Above all there is an awareness of a weakness in the part, and the patient will often involuntarily reinforce the area by pressure with his hand when coughing or sneezing.

Signs

Inspection reveals, in some cases, a swelling which is aggravated by straining and may go away spontaneously upon lying down. The swelling varies in size and shape according to the size and position of the hernia. At first it may not be visible at all. In infants or sparely built patients, the nature of the sac contents may be detected on inspection, and peristaltic waves observed should intestine be involved. This is most readily noted in umbilical herniae in thin subjects or infants.

If no swelling is present the patient must be instructed to cough whilst standing erect and a bulge sought.

Palpation of the suspected areas is essential both with the patient erect and lying prone. The classical impulse upon coughing is characteristic and elicited by placing the hand over the hernia, or, in the inguinal area by inserting one finger gently into the canal by way of the invaginated upper scrotal pole. Under these circumstances, when the patient coughs the swelling gives an EXPANSILE impulse which is readily detected by finger or hand. It should be emphasised, that the canal must never be dilated or coarsely handled during this/

this test, and some authorities go so far as to state that it should never be performed at all, condemning it as an unjustifiable insult to the integrity of the muscles.

When the hernia has been reduced and the patient is lying prone, the condition of the rings should be explored and the posterior wall of the canal palpated. A flabby internal ring or posterior wall may be a guide as to the type of operation which will be required to effect a sound repair.

During palpation of the swelling the contents may be reduced and where gut is implicated, with a characteristic gurgle. If omentum or a solid viscus is present the swelling will be firm and doughy. Omental adhesions may be palpable as firm nodules within the sac in spare subjects.

Percussion is not a very useful method of examination, but, when gut is present a tympanitic note may sometimes be elicited. This is especially so if the loop contains much gas. A dull note combined with a fluid thrill suggests that bladder may be present. Such a swelling will vary in size with micturition and without change in the position of the patient. Bladder will never be present in scrotal cases, but should be suspected in bubonoceles.

X-ray Examination In non strangulated herniae it may be possible to determine the contents of a sac by X-ray examination. The need for this is rare. Sometimes the method may be of value in diagnosing a rare form of hernia, for example properietal, intestitial, sciatic or internal hernia where the diagnosis by clinical means alone is uncertain.[20. 21.]

Pneumoperitoneum Farr [22] has advised the use of pneumoperitoneum as a diagnostic measure where doubt obtains. He claims that it (1) visualises the sac contents, shows reducibility the presence of adhesions and the position of the ring.

(2) demonstrates the patency of a processus vaginalis in "persons in whom a hernia cannot clinically be diagnosed although a so called "potential" hernia exists."

Differential Diagnosis

Hydrocele This may be confused with a scrotal hernia, but a hydrocele is usually translucent upon transillumination, does not give an expansile impulse on coughing, and has no reflex abdominal colic or digestive symptoms. It does not vary in size with posture or with exercise, and is irreducible.

Varicocele This is not difficult to distinguish from hernia, but may be to the unwary as it does give an impulse on coughing somewhat similar to that of reducible hernia. The varicocele is conventionally described as feeling like a "bag of worms." This description could hardly apply to a hernia.

Lipomata A lipoma within the inguinal canal may cause a swelling which does not vary in size with posture and is irreducible. It lacks the characteristic impulse upon coughing, and has a different consistency. Lipomata may be confused with femoral, small umbilical and hernia through the linea alba.

Inguinal Adenitis This is more likely to be confused with irreducible/

irreducible hernia, or when infected, with inflamed or strangulated hernia. If, however, there is softening of the adenitis the conditions may be confused. It must be distinguished from femoral and inguinal varieties. The cause of the adenitis must be sought in the lower extremity or foot. An adenitis generally involves more than one gland and is nodular on palpation.

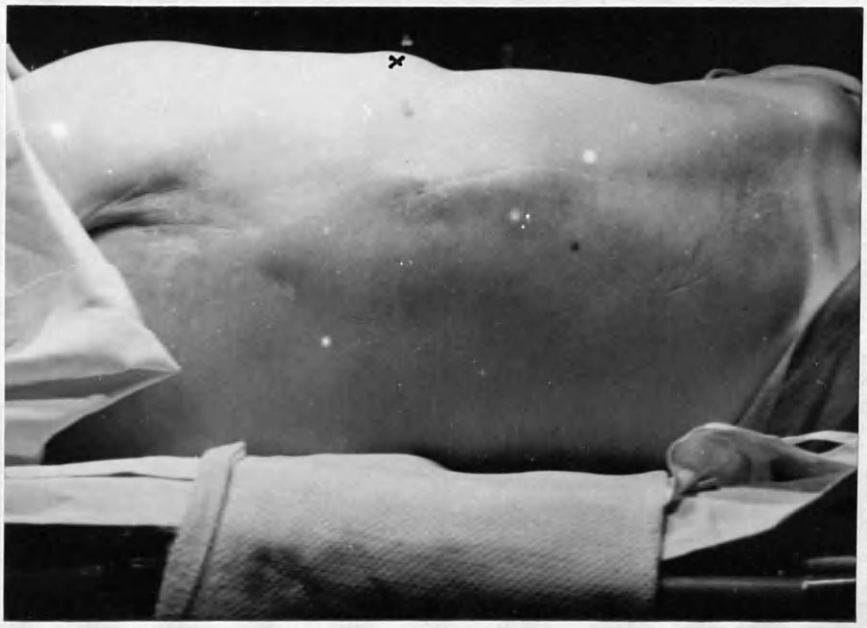
Cold Abscess The spine should always be carefully examined. However, one frequently has seen cold and psoas abscesses where no obvious spinal disease could be detected either clinically, or with the assistance of radiographs. There is, no impulse upon coughing, and the swelling may be more prominent when standing. Cold abscess may be confused with a lumbar hernia. Fig. 5.

Cysts and Newgrowths of the Inguinal Canal In the female a cyst of Bartholin's gland may lead to difficulty, and in both sexes, cysts and neoplasms may be found within the canal. Recently I removed an adenomyoma of the round ligament of the uterus which was diagnosed as an irreducible inguinal hernia.

Saphenous Varix Saphenous varix may be confused with femoral hernia, and, if thrombosed has been mistaken for a strangulated femoral hernia.

PROGNOSIS

A reducible hernia should give a satisfactory result with operation/



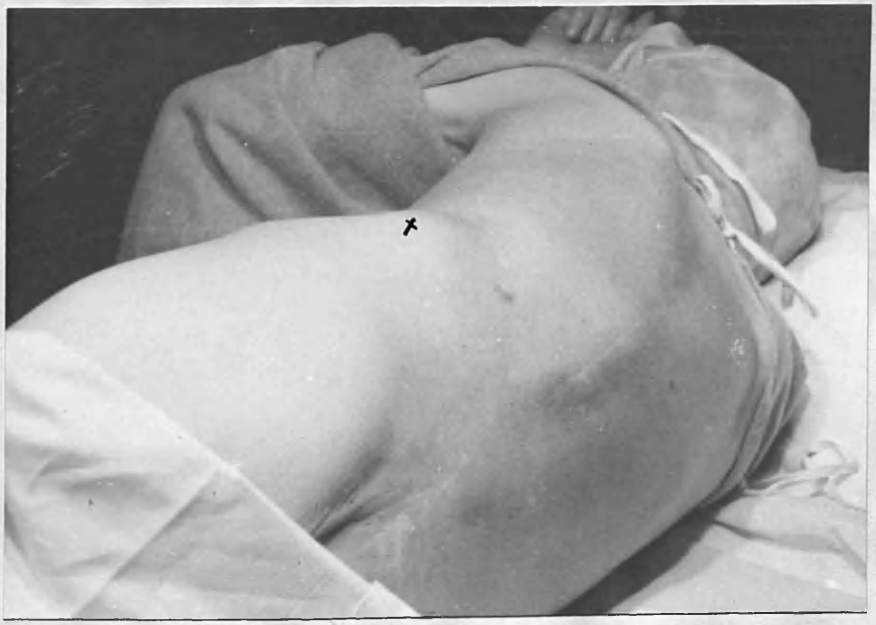


FIGURE 5

COLD ABSCESS OVER SITE OF LUMBAR HERNIA

operation, especially if it is performed before muscles have become incompetent. In early and small inguinal cases a conservative operation is indicated and good results are obtained by simple herniotomy. Where the muscles are weak, and in all ventral, umbilical and direct types a more elaborate operation is indicated. The success of this depends upon many factors, of which the choice of operation is not the least important.

The prognosis depends upon the skill of the surgeon, the choice of his operation, the efficiency with which it is carried out, the types of sutures used and the nature of the postoperative regime together with other factors. These are discussed in later chapters.

In the aged there may be a place for mechanical support by a truss, but if the general condition is reasonable good results can be had by operation. Elderly people find trusses uncomfortable, and, if they can pluck up their courage to have an operation, generally benefit by it.

CONTRAINDICATIONS TO OPERATION

The following conditions may be said to contraindicate operations of election for hernia.

(1) In weakly infants because such children do not stand operation well and also because increase in the weight and general condition may bring spontaneous cure.

(2) In the aged where the general condition of the patient is bad and complicated by some severe systemic condition jeopardising life.

(3) In the later stages of pregnancy. [43]

(4) Any advanced cardio renal disease.

(5) Any advanced pulmonary lesion such as tuberculosis, chronic emphysema or bronchiectasis.

(6) Malignant disease of any organ with secondary spread.

(7) In advanced cases of obesity, unless reduction in weight can be brought about.

(8) Where in a massive hernia there is doubt as to whether the contents can be returned to the abdomen and the contents are other than omentum.

(9) Where operation has previously been performed on at least three other occasions, and the hernia has recurred for the third time.

(2) IRREDUCIBLE HERNIA

Definition An irreducible hernia is one whose contents cannot be reduced back to the abdominal cavity.

All degrees of irreducibility may be found.

ETIOLOGY

The cause is the presence of adhesions anchoring the affected organ to the interior of the sac. This is most commonly so in chronic cases and where omentum is involved. It is an early complication of adult umbilical cases.

SYMPTOMS

The symptoms are similar to those of reducible hernia save that the swelling does not go away and may cause some increase in reflex abdominal colic or pain, some increased constipation, and some increase in local discomfort varying up to actual dragging pain over the swelling.

The larger the hernia the greater are these reflex and local phenomena.

There is always a past history of a reducible hernia, though a proportion of patients may have been unaware of any previous swelling. This is unlikely to be the case in intelligent people who take a healthy interest in their physical condition and personal hygene.

SIGNS

The physical findings are as for reducible cases save that the swelling cannot be completely reduced and does not vary much with posture. Impulse on coughing remains.

Palpation may provoke some local discomfort.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis is as for reducible hernia.

PROGNOSIS

The outlook is more serious than in the reducible types, but operation should give good results. Mechanical support by a truss must never be commenced, otherwise it may lead to contusion of the sac contents, and increase the already present risk of later obstruction and, or, strangulation.

Treatment must be carried out efficiently and early as the risk of further complications is real.

(3) INFLAMED HERNIA

Definition An inflamed hernia is one in which there is a peritonitis of the sac wall or of its contents.

ETIOLOGY

The causes may be trauma from a truss, from a blow, or from ill-advised attempts at reduction of an irreducible hernia.

Inflammation may arise from an inflamed viscus such as the appendix or terminal ileum, or from tuberculosis somewhere within the peritoneal cavity.

It is comparatively uncommon in inguinal hernia, but is especially frequent in long standing umbilical and femoral cases. The incidence of this complication rises with advancing age.

SYMPTOMS

The symptoms are obvious and may be severe. The mass is painful, tender to palpation, oedematous and presents the characteristics of any inflammation.

Constitutional upset may be considerable with pyrexia, increased frequency of the pulse, nausea, headache, and vomiting. The severity of the symptoms depends largely upon which viscus is implicated. With omentum alone symptoms may be transient and mild, but if the appendix is present they may be severe, termination in abscess formation, or an extension of the lesion to the general peritoneum unless relieved by operation.

The overlying skin may become ulcerated and fistulae develope. The large intestine is more often involved than the small.

SIGNS

The swelling becomes red, oedematous, boggy, tender to palpation, and fixed. The skin may show necrosis to any degree up to complete ulceration and fistula.

The patients exhibits the general signs of toxaemia.

PROGNOSIS

This is more grave than in the first two varieties, and depends upon the efficiency of conservative treatment.

SEQUELAE

If the inflammation subsides adhesions are left within the sac, which may bind it to its coverings, and lead to complete and permanent irreducibility of the contents.

TREATMENT

Treatment should almost always be conservative. Rest in bed is essential, and there should be support to the swelling by a scrotal bandage, but care must be taken, not to compress the part. Cold compresses are of value in younger people, but not in the aged where there is a risk of the cold causing skin necrosis. If local suppuration develops, the pus must be drained by simple incision.

A course of chemotherapy, sulphathiazole, 30 grammes over five days, is often helpful.

(4) OBSTRUCTED HERNIA

Definition An obstructed hernia is one containing intestine whose lumen has become occluded, but whose blood supply remains intact. The obstruction is frequently from within and due either to an accumulation of gas or faeces in the intestinal loop.

SYMPTOMS

The condition is usually gradual in onset, and there is past history of a reducible hernia over a varying period. The early symptoms are indefinite, but often include local pain in the swelling and some increase in its dimensions.

Vomiting is absent at first, and until the obstruction has become established it varies in time of onset according to the viscus involved. Transient constipation may be present for some time before the onset of symptoms, but, unless the condition is relieved, it will increase and eventually become absolute. The large bowel is often involved in obstructed umbilical herniae.

In the absence of further complications such as strangulation, there will be little other than local discomfort until the obstruction has been established for some hours or a few days. Then abdominal distension, vomiting, and dehydration begin to appear terminating ultimately in death unless treatment is carried out.

SIGNS

In the early stages there may be some increase in the size of the hernia which is, of course, irreducible. Impulse upon coughing is present until the very latest stages, and there is often little local tenderness on palpation. Occasionally, there may be pain and here an underlying mild inflammation is probably superadded.

The general condition of the patient remains good at first, but deteriorates with the advancing degree of obstruction.

PROGNOSIS

The prognosis is good in young and middle aged people provided treatment is commenced and effectively carried out. In the aged the outlook is more grave, and strangulation may be early.

TREATMENT

Palliative treatment is indicated where strangulation can be ruled out as the cause of the obstruction.

Rest in bed with the foot of the bed elevated on blocks is essential. No food is given, and only restricted fluids by mouth. High enemata are of value, but, if the condition is not speedily relieved, operation must be commenced. If there is any doubt about obstruction being complicated by strangulation, operation must be performed for its relief and palliative treatment abandoned.

SEQUELAE

If the obstruction is not relieved, strangulation is almost certain to follow.

(5) STRANGULATION

Definition A strangulated hernia is one which contains an abdominal viscus whose blood supply has been cut off in whole or in part.

ETIOLOGY

Strangulation is due to constriction of the sac contents which obstructs their blood supply. The site of the constriction is generally one of the abdominal rings, but may be the neck of the sac itself. Less commonly other causes are found.

The points of strangulation in order of their frequency are:

(a) The edge of the internal ring.
(b) The edge of the external ring.
(c) The edge of Gimbernats ligament.
(d) The margins of the linea alba.
(e) In the inguinal canal due to constriction by the fibres of the transversalis or internal oblique muscles.
(f) The neck of the sac.

1. Extrasaccular Constriction The hernial ring; in the inguinal variety this is usually either the external or internal abdominal rings. It is usually small and rigid, and, in the case of the external abdominal ring, is the sharp edge of the pillars of the external oblique aponeurosis.

The/

The ring may be the edge of Gimbernat's ligament in the femoral canal, a sharp margin of a defect in the linea alba or the edge of the umbilical cicatrix.

2. The Neck of the Sac This is an uncommon single cause of strangulation, but may contribute to the severity of a lesion caused primarily by the hernial ring.

3. Other Causes Intrasaccular strangulation is due to a variety of conditions most of which are uncommon.

(a) A diverticulum within the sac. This is more frequent in umbilical herniae, but is also found in large inguinal sacs.

(b) Constriction by intrasaccular adhesions in massive cases.

(c) Constriction of the intestine from an omental adhesion within the sac.

(d) Constriction of the intestine or mesentery from a long adherent appendix or Meckel's diverticulum within the sac.

(e) Strangulation due to volvulus of the sac contents.

(f) Retrograde strangulation or Maydl's Hernia. Here two loops of intestine are present in W form and the central loop is strangulated.

(g) Where there is an opening in omentum within the sac and intestine herniates through it. The margins of the omental opening act as the constricting mechanism.

(h) Haemorrhage occurring in the intestine lying within the sac.

In addition to these, other factors are of importance.

Site of the Hernia Strangulation is rare in direct inguinal, and when present is always associated with a funicular sac, never with the diffuse variety.

Strangulation is most common in femoral cases, next in umbilical and then in inguinal. 8. 13.

Sex Strangulated inguinal hernia shows an absolute increased incidence in females, though the total numbers are less in women than in men. Proportionately however, the condition is more common in women. According to Estor [7.] in 225 cases of strangulation collected in infants, 205 were in females. The rule is applicable to all age groups.

Age Strangulation is most common in the latter half of life, and rare before twenty. Several cases have been described in young people and infants, and one [24.] at two weeks.

Contents of Sac Almost every organ within the peritoneal cavity has been described in a strangulated hernia. The omentum and intestines are most commonly involved, but the vermiform appendix, bladder, ureter, uterus, stomach, and appendices epiploicae [25.] have all been mentioned. Meckel's diverticulum has been strangulated in inguinal and femoral herniae [26.] and strangulation of the caecum on the left side is not unknown.

Duration of previous Hernia A substantial number of herniae strangulate when they first appear. According to Berger [8.] out of 239 cases studied, 48 strangulated the first time they came down. I lately examined a man before lunch and observed the absence of hernia. During the same afternoon I operated upon him for a strangulated indirect inguinal hernia with gangrenous ileum. In Berger's series of 239 cases, 102 had been present for more than ten years.

Strangulation is frequently preceded by long standing irreducibility.

SYMPTOMS

The onset is sudden and may be associated with some exciting strain. Pain is severe, sudden in onset, and referred to the abdomen as well as locally. At first it is felt over the hernial ring and is sharp and griping with exacerbations due to peristalsis from above the obstruction. Referred pain to the abdomen develops later and may be referred to the periumbilical or hypogastric areas, less commonly to the epigastrium.

As the lesion progresses, the pain becomes more severe and eventually is continuous. The patient is restless and acutely distressed.

Nausea is early and rapidly followed by vomiting which is severe and continuous. Rarely there is no vomiting but then only in thecase of a partial enterocele or a Littre's Hernia.

The higher the site of the obstruction the more severe, early and continuous is the vomiting. At first it is reflex and projectile, but rapidly becomes continuous and the vomitus then consists of intestinal contents with a faecal odour. Vaughan [9] studied twenty-five cases of strangulation and found pain to be present in all, vomiting in twenty, and nausea without vomiting in two. Vomiting is an important factor in leading/

leading to the decline of the patient even after successful operation. Fluid loss must be replaced, and fully as important the chloride loss must be adjusted, and that early by intravenous infusion of glucose saline or plasma.

Comstipation may not at first be absolute but rapidly becomes so, and remains absolute in the absence of treatment. It is quite common with high strangulation to get a formed faecal return after even a second enema, and rarely there may be diarrhoea due to an enteritis below the obstruction.

The general condition of the patient is bad and deteriorates rapidly. Shock and prostration are early, persistent and may be profound. At the extremes of age shock is more severe and the classical signs and symptoms are observed.

Abdominal distention develops later and may be associated with a generalised peritonitis.

LOCAL SIGNS OF STRANGULATION

The swelling is fixed, tender, irreducible, painful and tense. There is no impulse on coughing. Fluctuation may be present in the later stages, but at first the mass is absolutely tense and firm. Owing to fluid accumulating within the sac, the percussion note is generally dull, and auscultation over the area demonstrates a complete absence of peristaltic sounds after the strangulation has become established.

With advancing pathology local signs of skin necrosis, gangrene and fistula may be observed with consequent reduction in the size of the swelling and discharge of foul material over the area. This is often associated with a relief in the intensity of the pain.

DIFFERENTIAL DIAGNOSIS

Partial Enterocele This is a dangerous condition when strangulated as the diagnosis may not at first be made owing to the small swelling, absence of absolute constipation, and the fact that vomiting is less severe. The canals and rings must be very carefully explored should the lesion be suspected. Any swelling present will be small, but a tense tender mass may be palpable in relation to one of the rings and a clue as to the underlying pathology. This condition is sometimes confused with a hernia containing an inflamed vermiform appendix.

Strangulated Omental Hernia Where omentum alone is within the sac the symptoms and signs, both general and local are less severe, and abdominal colic less marked. Vomiting may be absent and there need not be constipation. If the lesion is left alone, extension of the peritonitis to the general abdominal cavity is probable and the terminal result as grave as in other forms of strangulation [27]. Omental hernia when long incarcerated may form a local abscess in the sac. [28].

Inflamed Inguinal Adenitis This may readily cause confusion, but general symptoms are generally less severe, vomiting is mild, if present at all, and there is no referred abdominal colic or digestive upset.

Orchitis, Epididymitis The lesion is confined to the scrotum, and careful palpation of the canal and rings will clear the matter up.

Undescended Testicle Trauma to, or torsion of, an undescended testicle may be very difficult to distinguish from partial strangulation. Such lesions are extremely painful, there is nausea and possibly vomiting. Locally there is a tender, hard and fixed swelling which is associated with an absence of the testicle from the scrotum of the affected side.

DIFFERENTIAL DIAGNOSIS OF OBSTRUCTED, INFLAMED AND STRANGULATED HERNIA

Symptoms	Obstructed	Inflamed	Strangulated
Onset	Gradual	Gradual	Sudden
Impulse on coughing.	Present	Present	None
Pain	Varies but not severe	Not marked	Severe over hernia and abdomen
Swelling	Little tension	Less severe than in strangul.	Very tense
Vomiting	Usually absent	No tension	Severe and continuous
Constipation	Absent	Slight	Absolute
Prostration and shock	None	Absent	Severe in infants and the aged.

Symptoms	Obstructed	Inflamed	Strangulated
Pulse	Normal	Normal	Rapid, later weak and thready.
Temperature	Normal	Normal	Elevated at first, later subnormal
Local tenderness	Nill	Slight elevation	Severe
Frequency	Fairly common	Uncommon	Common

Murray [23] has reported a case which he operated upon for strangulated hernia and, on opening the sac released from it gas and greyish green fluid. The condition proved to be a perforated duodenal ulcer the products of which had gravitated into a patent hernial sac. If Murray was capable of this error it is probable that others may do likewise.

COMPLICATIONS OF STRANGULATED HERNIA

1. Reduction en Bloc This is the term given to the reduction of a strangulated hernia without relieving the constricting ring and freeing the blood supply to the intestine.

Classification:-

1. Properitoneal. Here the strangulated hernia is reduced into an empty loculus of a bilocular sac.
2. Interstitial reduction with rupture of the sac. Here the sac is ruptured and the intestine displaced to some position between the layers of the abdominal wall.
3. Interstitial reduction without rupture of the sac. Here the sac and strangulated viscus are together displaced to some position between the layers of the abdominal wall and the constriction is unrelieved.

In one of the Arris and Gale lectures for 1900, Moynihan described/

described a number of unusual herniae occurring in the inguinal region and among which was a type which he called "reduction "en masse," to differentiate it from the group of properitoneal herniae. [29] The true inguinoproperitoneal hernia must have (a) a hernial sac having two distinct loculi; (b) the inner loculus lying between the peritoneum and the fascia transversalis (c) the outer loculus lying in the inguinal canal or, in rarer instances, between the layers of the abdominal wall; (d) both loculi opening into the abdomen by a single orifice, the ostium abdominale.

Moynihan insisted [30] that the term "reduction en bloc (masse)" should be reserved for those cases that have the mutual relation of the sac and its contents undisturbed, where the entire mass is found behind the muscles and fascia, and not in the canal.

In searching the museums of London for specimens of interstitial and properitoneal herniae, he found that most of the preparations of this class, i.e., properitoneal hernia, were labelled as having been reduced en masse. This he regarded as an error, and stated that true cases of complete reduction are very rare. In the cases observed the herniae were chronic with loosening of the sac from the surrounding structures and usually due to long-continued and ill-advised taxis.

Frequency The condition is rare. Nason and Mixter [10] found/

found only three examples out of 632 herniae of all types, and in 12,000 cases collected by Eliason [11] there were none.

Etiology Indiscrete attempts at reduction by taxis are frequently blamed. In Nason and Mixter's investigations this was not so in the cases discovered. The cause is otherwise unknown.

Botteselle [31] reported a case of reduction en bloc in a deaf mute where the condition was not identified until ileus was well established.

Everidge [32] also reported a case but with a successful issue after laparotomy.

Symptoms and Signs There is an immediate past history typical of strangulation with a visible tense painful swelling over a hernial orifice. The swelling is reported to have disappeared but symptoms persist. The general condition is not improved. Locally the ring is often slightly dilated and in relation to it can be palpated the swelling which has not reached the interior of the abdomen. After reduction of the swelling there is often an increase in the severity of symptoms and rapid deterioration.

Treatment Immediate operation is essential and a generous incision desirable. The extent of the operation depends upon the condition of the strangulated viscus, but, no more should be done than is essential to save life.

Prognosis The prognosis is always grave, and becomes more so with delay in commencing operation. It must be remembered that even with early operation, the mortality rate may be high if there is extensive gangrene, or if the fluid and chloride loss are not replaced. The prognosis depends upon the skill, surgical and medical of the surgeon, the duration of the lesion, and the age of the patient.

2. Separation of the Mesentery This is a rare complication of hernia but is sometimes found in strangulation. The separation occurs between the intestinal border of the mesentery and the intestine thus devascularising a varying length of the intestinal walls depending upon the severity of the lesion.

Rabere and Charbonnel [12] described several cases and state that it is generally due to traction on the mesentery and predisposed to by gangrene of either gut or mesentery.

Watson [3] collected thirteen cases from the literature, and, of these, four died after operation.

Treatment consists in excision of the gangrenous mesentery and bowel with anastomosis of healthy gut ends to restore continuity. Haemostasis must be particularly efficient as there is some risk of secondary haemorrhage.

3. Intestinal Haemorrhage Intestinal haemorrhage may follow attempts at reduction by taxis or operation for strangulated hernia.

EARLY INTESTINAL HAEMORRHAGE

Etiology The principal factors at work are: [3]

1. Ulceration of the mucosa resulting in the casting off of an eschar. This may occur some distance from the original point of constriction.

2. The collection of an exudate of blood between the layers of the intestinal walls following upon trauma from taxis, or violent handling of the gut at operation.

3. The rupture of the arterial capillaries as a result of the pressure in the arteries when circulation is resumed.

4. Thrombosis of the mesenteric veins, including congestion and oedema, with finally haemorrhage, due to ulceration of the mucosa.

5. Thrombosis of the intestinal blood supply as a result of resection of the mesentery or the omentum.

6. Sudden dilatation of the mesenteric arteries may follow the restablishment of a normal circulation after a temporary occlusion (Litten).

7. Disease of the herniated viscera or of the peritoneum.

Incidence of early Intestinal Haemorrhage

Early intestinal haemorrhage is less common than delayed or late haemorrhage, although it may be more frequent than statistics show, but be overlooked through a failure to examine the stools for blood. Also, small clots of blood may be/

be so intimately mixed with the faeces as to defy detection unless blood tests are carried out.

Symptoms and Signs The onset of haemorrhage is usually associated with a slight elevation in temperature followed by the appearance of melaena. The bleeding may continue for several days, but is seldom profuse. A subnormal temperature and evidence of shock are observed in more severe cases. Profuse haemorrhage generally occurs in massive chronic hernias, and strangulation may have been but of short duration before its onset. In these cases the strangulated loop is generally large and the prognosis grave.

DELAYED OR LATENT HAEMORRHAGE

Delayed haemorrhage usually appears during the second week after operation. As a rule, the general condition of the patient up to this time has been satisfactory when bleeding suddenly appears without prodromal symptoms, and is often considerable. [3] The prognosis again is grave.

Etiology Delayed haemorrhage is more often seen in elderly patients, suffering from arteriosclerosis. The mesenteric vessels become thrombosed and an extensive haemorrhagic infarct developes in the intestinal wall.

Prognosis The prognosis of early haemorrhage is fairly good as blood loss is scanty and the condition may improve with conservative treatment.

The prognosis of early haemorrhage is usually favourable because/

because the amount of bleeding is small and it yields to palliative treatment. Delayed or late haemorrhage has a grave outlook because the bleeding is profuse, and as the condition is generally found in elderly arteriosclerotic subjects, the chances of spontaneous cure are remote.

Treatment When the haemorrhage is not profuse, the treatment is usually palliative. A liquid or soft diet should be given to diminish peristalsis as much as possible. In severe cases nothing is given by mouth; all fluid and food being administered per rectum for several days after the blood has disappeared. To control the haemorrhage, the patient is kept quiet for two to three weeks, and opiates given to check peristalsis, an ice bag applied over the abdomen, calcium chloride solution is administered, and horse serum, or ergotin given hypodermically. If there is diarrheoa, it should be controlled by opiates to which a styptic has been added. After the haemorrhage is checked, the bowels should be moved daily with a mild laxative or a low enema.

Stenosis of the Intestine after Strangulation Stenosis or stricture of the intestine resulting from strangulation is comparatively rare. Probably the first case was reported by Acrel [33] in 1772. Others more recently have been reviewed by Cotte and Leriche [34].

Classification The constriction of the intestinal wall may be annular or tubular.

1. Annular Constriction Annular constrictions are usually solitary. When double, they correspond to the two extremities of the strangulated loop of intestine. The constriction is narrow, and the serous surface of the bowel dull and grayish in colour.

2. Tubular Constriction Tubular constrictions are generally single, and follow ulceration and cicatrization of the mucous membrane. In severe cases the muscular layers may also be involved. Tubular constrictions may be up to 2 inches in length, and the lumen of the intestine may be so narrow as to admit only a probe.

Etiology The condition may be due to the diminished blood supply, which results if too small an amount of mesentery is left after intestinal resection, or if an accessory blood supply is destroyed when adhesions are separated. If too large an area of gangrenous intestine is inverted at operation for strangulated hernia, stenosis may follow. Other causes are: contusion, trauma to the intestine by a truss, the presence of foreign bodies in the sac, adhesions within the sac, localized peritonitis, tuberculosis, and tumours involving the intestine.

Acute Stenosis In acute occlusion symptoms are obvious. Vomiting becomes frequent, abdominal distention increases, the pulse is feeble, the temperature subnormal, and breathing laboured.

Chronic Stenosis In chronic occlusion the onset is gradual and symptoms increase in severity. Vomiting follows when the stomach becomes distended. The patient suffers from inanition and progressively loses weight. Abdominal distension becomes severe unless relieved by vomiting or by flatus passing the obstruction. This last is accompanied by a characteristic sound on auscultation, which Jaboulay and Patel [35] have likened to the "glou-glou" sound of a bottle being emptied of liquid.

VOLVULUS OF THE INTESTINE COMPLICATING STRANGULATED HERNIA

Volvulus is a rare complication of strangulation, and is almost always associated with inguinal hernia. However, a few cases of umbilical, obturator and femoral varieties have been reported in the literature.

Anatomic Varieties Knaggs [36] divided volvulus complicating strangulated hernia into three groups:

1. Volvulus of a portion or of all the herniated intestine.
2. Volvulus of the small intestine with one loop in the hernia.
3. Volvulus of the herniated bowel occurring immediately after its reduction.

Degree of Torsion Symptoms of volvulus may be produced by a quarter twist (90 degrees), a half turn (180 degrees), or a complete twist (360 degrees). Rarely the loop may rotate more than 360 degrees.

Etiology Volvulus or torsion of the intestine is rare save in inguinal hernia, and then is almost always found in the latter half of life. It is often due to continual movement of nonadherent intestine within the sac. Acute volvulus is sometimes due to attempts at taxis. Torsion of the intestine may also be complicated by torsion of the omentum.

INCIDENCE OF STRANGULATED HERNIA

Strangulation is the most common complication of herniae and of 10,000 cases of hernia investigated by Berger [13] 250 showed it.

PATHOLOGY OF STRANGULATION

1. The Sac The sac becomes tense, oedematous and congested and may in severe cases show local ulceration, gangrene and necrosis.

It may contain clear fluid in an early and incomplete degree of strangulation, but later, as the lesion increases in severity this fluid becomes blood stained, at first red, later brown, and finally with infection, turbid and highly virulent. The infection comes from organisms which have penetrated the intestinal wall. This fluid may flow through the mouth into the general peritoneal cavity or contaminate it at operation.

2. The Intestine The length of intestine strangulated varies/

varies up to several feet, but is usually not large. Small herniae are more liable to strangulation than large as the ring is more narrow.

When strangulation developes the intestine passes through three phases, congestion, inflammation, and gangrene.

Congestion At first the viscus is of normal colour, but, with venous obstruction turgid veins can be seen in the mucosa and the intestinal walls become bright red in colour. Later they become dark purple and oedematous. The serous coat at first is normal, but later dull, lacking in lustre and swollen.

Inflammation With advancing venous stasis and progressive interference with arterial supply, ecchymosis appears on the intestinal walls, the serous coat becomes dull and covered with a fibrinous exudate. Oedema and purple discolouration become pronounced.

Bacteria migrate through the affected gut wall and set up an acute inflammation which involves both intestine and sac, and causes the exudate within the sac to become purulent.

These effects are most pronounced at the site of constriction where the constricting mechanism may furrow the intestine and actually cut into the serous layer in later cases. This may proceed until the lumen of the gut has been opened and its contents liberated into the sac.

Gangrene Ulcers form during the process of acute inflammation and/

and may coalesce to form an area of local gangrene. This is frequently most acute at the neck of the sac, but is also seen at other areas. There may also be ulceration of the mucous membrane commencing from within and due to the impaired blood supply.

Gangrene is often obvious within a few hours of the commencement of strangulation, and when established the intestine affected is no longer viable. The walls are plum coloured, oedematous and friable. Later the colour may be ash grey and overlaid by a thick deposit of altered blood and exudate of brown or green colour.

The extent of the gangrenous area varies, and the whole loop is not at first involved. The condition appears first in the proximal part of the loop and in relation to the constriction, but it later spreads to involve the whole of the hernia. Perforation of the intestinal walls appears during this stage, and most commonly on the convexity of the loop.[14] The mesentery of the strangulated bowel undergoes changes similar to those already described. It is oedematous, haemorrhagic and congested. The vessels thrombose and ulceration or gangrene occur as terminal events.

TREATMENT OF STRANGULATED HERNIA

The treatment depends largely upon the condition of the bowel at the time of the operation. No conservative treatment will/

will be of value and operation must be performed as early as possible. The operation consists of relieving the constricting mechanism which should be cut under direct vision. The bowel is then inspected and, if nonviable must be resected. If viable, it should be restored to the abdominal cavity, but only when there is no risk of introducing infection to the peritoneum. If there is only a small area of necrosis involving a part of the circumference of the wall it may be invaginated by a purse string suture.

The detailed treatment is dealt within a later chapter. In the aged the operation should always be performed under local anaesthesia.

Taxis Taxis is often performed in an attempt to reduce the hernia. It is not a wise procedure and is here associated with certain dangers. These are:-

(1) The hernia may be reduced "en masse" with a persistance of the underlying strangulation.

(2) Taxis may cause contusion of the affected viscus.

(3) There may be rupture of the intestinal wall.

(4) Infected material may be expressed from the sac into the peritoneal cavity.

(5) Even if reduced the intestine may be so diseased as to cause peritonitis.

(6) There may be intestinal haemorrhage due to violent attempts at reduction.

(7) There may be only incomplete reduction, a part of the strangulated organ remaining in the sac. This danger is most real in obese persons.

(8) There may be a torsion of the intestinal loop which can persist after reduction.

(9) The sac may rupture with extraperitoneal reduction of the hernia.

(10) Intestinal ileus may follow forceful or often repeated taxis.

The dangers of contusion, even of mild degree have been emphasised by Chabrut [37] who reported ten examples, eight of which were fatal.

MULTIPLE HERNIAE

Direct inguinal herniae are often bilateral, and may be associated with an indirect on the same side. This combination is known as the "saddle bag" or "pantaloon" type of hernia, and, if one sac is missed at operation is an explanation of "recurrence" in some cases.

There may also be an associated femoral or umbilical hernia in the same patient.

Indirect inguinals may also be bilateral, and the tendency seems to be greater in males than in females. As life advances a patient with one hernia may acquire another on the other side, and this is considered by Watson to be so in 36.6% of cases. [3]

HERNIA IN RELATION TO GENERAL HEALTH

Many people endure the hernia for years without even wearing a truss, and ultimately seek medical help only because of increasing size of the swelling. The condition is compatible with good general health.

The severity of symptoms depends upon the site of the condition, the abdominal organ involved and the size of the swelling. In early cases there may be so much reflex digestive disturbance and local discomfort that the general health is impaired. More usually there is no general disturbance until the development of obstruction, inflammation or strangulation. Constipation may be irksome in large cases, and some people may become neurotic or neurasthenic.

There can be no doubt that even in those herniae which are unassociated with constitutional disturbances, the lesion should be treated. Successful operation will benefit the patient considerably.

THE TRUSS

From early days, support to the hernia has been practiced as a sound method of treatment. There is still a place for the truss, but only where the patient refuses operation, in certain infants and children, and in the aged where the general health of the patient precludes surgical intervention. A truss may be a misery to its wearer unless accurately measured and fitted. In old people especially its use is often irksome, and they are amongst the most grateful patients for successful operation.

It is said that a truss should be regarded by the wearer with no more interest than his tie or underpants. That it should/

should occasion him no discomfort. Doubtless that is so, but frequently it is ill-fitting or uncomfortable to a tender skin, and rare if ever so unobtrusive as instrument makers would desire one to believe.

MORTALITY RATE AFTER OPERATIONS FOR HERNIA

In nonstrangulated cases the death rate is lowest in the young and highest in the aged. It is less than one per cent in most clinics, and in my series is .25%.

The death rate in complicated cases depends upon the age of the patient, the nature of the complication and its duration. For early strangulation treated within twelve hours the figure is approximately 5%, during the second twelve hours it rises to 10% and thereafter to between 40 and 70% at the end of four days. [15. 16. 17.]

COMPLICATIONS OF HERNIA OPERATIONS

Meteorism Gas pains are fairly frequent after herniotomies, but respond well to treatment. Prostigmin in small repeated doses plus ox bile enemeta are useful. Alkalies may be given and also aqua menth. pip... Heat applied to the abdomen in the form of stupes often affords relief and finally the elevation of the upper part of the body so that the patient is sitting in a semi-Fowler position is useful.

Occasionally these pains defy all methods of treatment and/

and persist for several days, but they rarely cause serious worry to either patient or surgeon and are most frequently transient.

Wound Sepsis Figures for wound sepsis vary widely from 0% to 10% in different clinics, but the incidence is higher after operations for complications such as incarceration and strangulation. O'Shea [45] found out of 1016 operations a 3.8% incidence of sepsis in umcomplicated cases and a 13.5% incidence in emergency operations.

Retention of Urine or Dysuria Certain people, and especially men, have difficulty in evacuating the bladder after a hernia operation. The difficulty may last during the first few days of the postoperative period. Conservative measures should be tried in the first instance, running water into a basin, giving cold compresses to the hypogastrium, or administering a drug such as carbochol. Under no circumstances must the patient be permitted to remain long with a distended bladder, and if conservative measures fail, catheters must be passed twice or three times per day until the normal reflexes return. Catheterisation must be carried out with full aseptic precautions.

This dysuria is always temporary.

Pulmonary Embolism This rare complication may arise in any patient and after any operation. It is more common in the latter half of life and appears around the tenth postoperative day.

A few years ago I saw a typical pulmonary embolism in a man of 30 who had had a simple herniotomy performed. The condition was fatal in ten minutes, and developed on the 21st day when he first arose from bed.

Mayer [18] has urged postoperative exercises in bed to minimise the risk of embolism. These exercises are also of value in restoring tonus to the weak abdominal muscles and reducing risk of recurrence. [19]

Acute Dilatation of the Stomach This may develop insidiously, and more especially after operations for strangulated hernia. Nausea may be the first symptom and belching give temporary relief. There may be little or no abdominal pain until the stomach has become enormously dilated. The general condition rapidly deteriorates.

Treatment consists of gastric lavage four hourly with 5% sodium bicarbonate lotion. The stomach should be emptied at each aspiration, washed out with the lotion and a small amount left in situ. Vomiting should not be permitted to develop or continue, and can be controlled by lavage and aspiration.

Fluid loss must be combated by intravenous or rectal infusions of glucose saline.

The position in bed should be frequently altered and a firm abdominal binder applied.

Intestinal Ileus This may be present to any degree and is capable of causing death if unrelieved. Progressive abdominal distension developes with absolute constipation in the established case. Vomiting ultimately leads to severe fluid and salt loss. It is eventually continuous and in late cases is faecal.

The distended abdomen is tympanitic on percussion, and painless unless peritoneal irritation or inflammation become superadded. Treatment consists in administration of prostigmin four hourly in small doses combined with frequent enemeta of turpentine, soap and water, coffee or ox bile. A flatus tube may be passed and left in situ. Gastric lavage through a Ryle's stomach tube may be of value and if the tube is left in situ the strain of vomiting is relieved.

Fluid loss must be combated and continuous intravenous drip infusion of glucose saline or distilled water and glucose commenced. Care must be taken not to waterlog the patient at this stage and no more than ~~three~~ six pints of fluid should be thus given during the twenty-four hours.

Postoperative Bronchitis and Pneumonia These complications are frequent and discussed in full in the Chapter dealing with anaesthesia. They are probably most frequent in umbilical and ventral cases, amongst the obese and in cases complicated by strangulation.

PREGNANCY AND HERNIA

Operation of election should be avoided in the later months of pregnancy, but should it be essential, may generally be carried out without prejudice to the foetus or mother.

The only essential for preventing a miscarriage is to avoid reflex contractions of the uterus by means of morphine in the early postoperative period. [44]

PAINFUL SCARS

A painful scar is due to inclusion of sensory nerves in the deep sutures or scar tissue. The condition is most common in relation to scars over the inguinal canal, and there is due to pressure on the iliohypogastric or ilioinguinal nerves.

When the pain is confined to the skin incision, it may be relieved by massage or X-ray therapy. If these measures fail, it may be necessary to excise the scar. In that event meticulous care is needed in order to avoid formation of excess of new scar tissue. This danger may be minimised by using very fine sutures and taking care to avoid tension on the parts.

Keloid Change Keloid scars may be both painful and ugly. They are best treated by massage and X-ray therapy. Operation is often unsatisfactory.

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CHAPTER III

TREATMENT OF COMPLICATIONS

INCARCERATION

Operation must be advised and carried out owing to the risk of later strangulation. As the patient is in good general condition as a rule and there is no gangrene of bowel or peritonitis, an operation of election can be performed which does not differ substantially from the uncomplicated case.

Care must however be taken to free the adhesions which have lead to incarceration, and to return the viscus to the abdominal cavity in healthy condition and free from trauma. A device that is applicable to all forms of adhesions and to all forms of complications from incarceration to mild strangulation, is to leave any adherent peritoneum attaching to the gut as a margin or cuff of appropriate length, having clipped away the redundant portion. This fringe of peritoneum can be utilised to cover any irritated area on the bowel wall which can thus be restored to the abdomen in good condition. [1]

The sac may be densely adherent to its content, in which case it may be opened proximal to the neck and the adherent peritoneum dealt with as above. Care must be taken not to open into the lumen of any hollow viscus in mistake for the sac.

When the affected organ has been safely reduced, the sac may still be densely adherent to structures around and require careful dissection before removal. In the inguinal region damage to the vas is possible at this stage and must be avoided.

Occasionally in a large sac containing omentum it may be deemed safer and more expedient to remove the fibrosed omentum with the sac. This is easily performed but care must be taken to ensure that the omentum is adequately ligated and no intraperitoneal haemorrhage follows.

OBSTRUCTION IN THE ABSENCE OF STRANGULATION

The essential of treatment is to free the constricting mechanism, thus reducing the obstruction and return the affected viscus to the abdominal cavity completing the operation by a plastic repair.

The need for treatment is more urgent than in simple incarceration, but less so than for actual strangulation. No time should be lost however as, once obstruction has become established, strangulation is imminent.

The canal is opened up by the conventional approach, and the hernia exposed. The constriction may be at the site of the pillars of the external ring, may be a band of thickened peritoneum in relation to the neck of the sac at the internal ring or to any fascial or ligamentous structure in the area, including the lateral border of the rectus muscle.

When the site of obstruction has been identified, it must be freed by careful incision with a sharp knife, and taking infinite care not to traumatise any other structure nearby. The most dangerous area is the peritoneum at the neck of the sac, and here a thin guarded scalpel blade is a convenience and adjunct to safety.

When the obstruction has been found the sac must be fully opened and the contained viscus exposed. Usually the area of pressure on its walls will be identified as a blue or congested line or streak and some difficulty may be met in deciding whether or not there is actual local gangrene.

The affected viscus may be then gently bathed in warm sterile saline and the circulation will usually return, the congestion reduce in degree and finally disappear. The gut may then be restored to its normal position.

Where a definite area of local gangrene remains this is usually only a small part of the wall and capable of being buried by a carefully applied purse string suture. It must be emphasised that NO resection should be carried out, and generally the viscus can be returned to the abdomen with safety.

When gangrene is present the condition is allied to that of strangulation and will be considered in the next paragraph.

TREATMENT OF STRANGULATED INGUINAL HERNIA

Preoperative Treatment For early cases, that is under twelve hours of onset, no special preoperative treatment is indicated.

1. Treatment of shock. That is applied through the medium of guarded water bottles and the "heat cradle." Morphia grs. $\frac{1}{4}$ and scopolamine grs. 1/150 are injected subcutaneously; finally a 5% glucose saline drip is established and connected to a vein. This drip is maintained throughout the operation and ultil a variable period of the post-operative phase.
2. A pint of blood may be added during the operation if haemorrhage is excessive, and in any event if toxaemia is advanced.
3. Enemeta. No enema or aperient has to be given before operation.
4. Catheterisation. Ensure that the bladder is empty before taking patient to theatre.
5. Duodenal drainage. Where vomiting or distension are urgent this measure is of value in aspirating vomitus, preventing regurgitation of vomitus into the air passages during operation, and in reducing distension.

Anaesthetic Local anaesthesia is the method of choice.

OPERATIVE TECHNIQUE

The canal is exposed and freely opened up, the hernial sac identified and opened widely up to its neck.

The only points in the early stage of the operation are to ensure that the incision is generous, and secondly, in dealing with the sac to avoid damage to its distended, congested and friable contents.

When the sac has been opened there will be an escape of fluid. This may be serous, sanguinous or purulent. In any case, it contains pathogenic organisms and must be carefully mopped/

mopped up and the wound flushed with saline. A specimen of the fluid should be collected and sent for culture. Where the fluid is sanguinous the implications are serious. The condition is probably advanced and gangrene both established and extensive.

The affected viscus is now withdrawn into the wound and carefully inspected. It may be:

1. Viable. Here, only the venous return has been interfered with and the affected portion has become congested, swollen, oedematous and purple in colour. The gut however retains its power of peristalis, but becomes distended and tense. The arteries can be palpated pulsating in its mesentery.
2. Non Viable Gut. Here there are haemorrhagic infarcts in the walls of the strangulated intestine. These arise from rupture of the walls of the distended veins. Extravasated blood permeates through into the lumen of the bowel and into the sac, providing an ideal nidus for infection, and the bowel wall loses its shiny appearance, becoming turgid and greyish or green in colour. Peristalsis is no longer seen and the arteries cease to pulsate.
3. Stage of Gangrenous Gut. The affected portion of gut now becomes gangrenous. Decomposition usually commences first at the site of constriction, but rapidly involves the entire loop. Perforation of the gut wall is followed by abscess formation within the sac and possible later faecal fistula.

   As the site of constriction is often the earliest site of gangrene the loop of intestine must be well pulled down into the wound and thoroughly explored. The gut above and below show signs due to their having been implicated in an acute obstruction.

When the bowel has been explored a decision must be made as to how the operation is going to be concluded. It may be categorically stated that no more must be done than is essential to save life.

TREATMENT OF VIABLE INTESTINE

This is returned to the abdomen when it has been ascertained that the circulation has not been permanently impaired.

The wound is then closed and NO elaborate repair is performed. The object is to save life. Plastic repair can be done later if necessary.

Rarely the patient may be in excellent condition, such that further treatment may safely be performed and then the operation may be finished along conventional lines. This must be regarded as the exception rather than the rule.

TREATMENT OF DOUBTFUL INTESTINE

This centres around the experience of the surgeon, the condition of the patient and the extent of the doubtful area.

A small patch on the anti-mesenteric border of the gut may be safely invaginated by a purse string or Lembert suture, PROVIDED this manoeuvre will not unduly narrow the lumen of the bowel.

In extensive cases and where the recovery of the loop is considered to be too doubtful for conservative measures, more radical treatment becomes unavoidable.

TREATMENT OF GANGRENOUS INTESTINE

This must be considered under at least two headings:

1. Where the large bowel is implicated.
2. Where small bowel is involved.

1. Large Bowel Strangulation Resection with anastomosis MUST NOT be performed. The lifeless loop should be exteriorised and drained, or a Paul-Mikulicz resection established. In either case, the colostomy will later require to be closed extraperitoneally six or eight weeks later. Alternatively, and only where there is a small local patch of gangrene, this may be invaginated with a purse string suture.

2. Strangulation with gangrene of the small intestine. Several measures may be adopted.

(a) Primary resection of bowel with anastomosis. This operation carries with it a high mortality rate, up to forty or fifty per cent. It is, nevertheless, the ideal method for children and where the patient is in good condition.

(b) Exteriorisation. Two methods may be followed.

1. Where the bowel is brought up to the surface as in a conventional colostomy and a glass rod passed through the mesentery to prevent its return to the abdomen. The loop may be excised and a tube inserted into each open end, anastomosis being performed later when life is safe.

2. The strangulated loop is brought to the surface together with healthy bowel above and below. A lateral anastomosis is then performed to bypass the necrotic loop. The site of the anastomosis is returned to the abdomen, the affected loop being retained outside. An enterostomy with a catheter is made above the anastomosis. Twenty four hours later the exteriorised loop is resected. Later the fistulae are closed with the enterostomy tube.

Estape [2] advises exposure of the strangulated loop followed by a pararectal incision in order to find the afferent/

afferent and efferent loops relating to the sac. These are then anastomosed by a Murphy button and the incision closed. Attention is then given to the gangrenous herniated loop of bowel which has meanwhile been surrounded by a gauze pack. He attaches this loop to the skin and permits it to slough away. The resulting fistula heals he finds, in approximately one month.

Excoriation and autodigestion are unpleasant sequelae of any exteriorisation process, and primary resection with anastomosis is preferable when possible.

The principles of the treatment of strangulation have been outlined but precise operative technique ommitted. This properly concerns a textbook on operative surgery, and is, in itself a large subject to cover adequately.

POSTOPERATIVE TREATMENT

The postoperative treatment of incarceration, contusion and obstruction vary but little from that of the normal hernia repair.

The patient is allowed one pillow in bed, not permitted to sit up until the third week of his postoperative period, and allowed out of bed on the twenty-first day. An aperient is given on the second night and the bowels encouraged to move on the third day. Any minor complications such as flatus, urinary retention or postoperative sickness are dealt with

in/

in the usual fashion. Deviations from such a routine are indicated in cases of strangulation, where the bowel is viable, and also where resection has been performed.

If it has been necessary to perform a resection, there will be a degree of peritonitis, local or general. If the bowel is viable but diseased there will still be peritoneal irritation. Treatment in the first five postoperative days should be directed to give maximal rest to the bowel, adequate fluid intake to the patient, and chemotherapy to deal with any latent or manifest infection of the peritoneum.

1. Rest to the Bowel This can best be achieved by forbidding the intake of food or fluids by mouth, and the careful use of small repeated doses of morphia.

It has been argued that it is not necessary to restrict all fluid intake by mouth, as the digestive secretions themselves compel peristalsis to take place though to a limited degree. There is no argument against restricting all fluids orally however, other than the confort of the patient and that need not be disturbed unduly by the suggested regime. In any case no risk should be taken which may lead to further danger to his life and until it can be proven conclusively that the administration of fluids by mouth in such cases is entirely harmless they should be forbidden.

The routine followed in all cases of peritonitis in Woodend and Oldmill has been very successful and similar experiences have been found in the Aberdeen Royal Infirmary.[3].

The essentials of the regime are:

(a) No fluids or food are given by mouth during the active period of peritoneal infection.

(b) An intravenous drip is established by cutting down on a vein and inserting a glass cannula. Sharp needles are not advised and experience has suggested that satisfaction to everyone concerned is more likely to follow open exposure of the vein. The drip is maintained for several days until improvement in the patient's general and local condition permit its removal.

(c) For an adult four pints of fluid are given intravenously every twenty-four hours. These consist of alternate pints of 5% glucose in saline and 5% glucose in distilled water. Blood chlorides can be checked daily if necessary.

(d) The nursing staff are required to give unremitting attention to the hygene of the mouth.

(e) Morphia in doses of one sixth of a grain are given three or four times in the first twenty-four hours, and gradually reduced daily over three or four days.

2. Adequate fluid Intake The four pints daily are enough for the average case, and care must be taken not to give too much fluid lest hypostatic pneumonia result.

3. Chemotherapy Penicillin or soluble sulphonamide preparations are given in saturation doses through the intravenous drip to effect an optimum concentration in the blood over a period of five days. Rarely sickness may require the drug to be stopped, either temporarily or permanently.

MAYDL'S HERNIA

Maydl's hernia, or hernia by retrograde strangulation, is rare and a special type of strangulation presenting points of interest.

The seat of the strangulation is at the neck of the sac, but the diseased loop lies in the abdomen. Various forms have been described but characteristically the bowel descends into a sac in the form of a W, the two external loops being connected by an internal or intraabdominal loop which may be strangulated. At operation the external loops may appear normal, and the risk is that they may be replaced into the abdomen before inspection of the intervening portion. If this is gangrenous or its vitality seriously impaired a fatal issue is probable.

Retrograde strangulation has been described as affecting the bowel, omentum, the appendix and the Fallopian tube. [4.] Important communications have been made by Lejars [4.], Bell [5], Mamen [6], and Polya [7]. Lejars emphasises the importance of inspecting all suspicious loops with care both proximal and distal to the neck of the sac.

Mamen reported one personal case and discussed sixty-two complied by Polya. The ages ranged from 7 to 76. In two of them there was no operation and death followed after two days. Thirty-one cases were reducible at operation and of these four died, and in three cases there were three loops of the intestine involved in a sort of double W.

Other than remembering to inspect the gut carefully above and below the neck of the sac there is no special feature about the treatment of Maydl's hernia. The same principles are observed as obtain for ordinary strangulation.

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CHAPTER 4

ANAESTHESIA

This section will not be devoted to a discussion on the relative merits of a succession of different anaesthetic media, but is intended merely to indicate certain aspects which are apposite to the subject matter under discussion.

In the operations for repair of any type of hernia, muscular relaxation should be as complete as possible. In whole skin graft repairs it is essential that the muscles be completely relaxed, otherwise when the graft has been inlaid and apparently adequately tight, subsequent muscle relaxation will render it slack and useless, vitiating the entire operative principle.

Thus no matter what type of anaesthetic is adopted, complete muscular relaxation is absolutely essential.

In my own view, the most satisfactory method of achieving this end is by administration of nitrous oxide, oxygen and ether, combined with preliminary premedication of three quarters a c.c. omnopon and scopolamine one hour beforehand.

In view of the fact that intratracheal intubation cuts down the total amount of anaesthetic used, it is desirable from every point of view. In the hands of a skilled anaesthetist trauma to the nasal and pharyngeal passages is negligible. In inexpert hands, however, the method should be avoided.

So far as the place of anaesthetics in the etiology of recurrence is concerned, it may be accurately said that any patient who, after having had a herniorrhaphy performed develops a severe bronchitis or pneumonia, runs an increased risk of recurrence as a direct result of severe coughing in the early stages of convalescence. It is thus important to find if there is any one method of anaesthesia which carries with it a low post operative chest complication rate, and if this can be found, to use it.

Squadron Leader Lucas [1] has investigated with some care the incidence of post anaesthetic chest complications and his findings are indicated elsewhere. The Table of his results is reproduced.

The whole question of the etiology of post operative bronchitis and pneumonia is involved, and in many respects undecided. It is not suggested here that the onus of responsibility for these complications rest solely on either anaesthetist or anaesthetic. Other factors are involved, some of which probably are under the control of the surgeon. Nevertheless, some measure of responsibility can be laid upon the anaesthetic media used and upon the anaesthetist's skill, or lack of it. In the remarks which follow, only the place of the anaesthetic is reviewed.

TABLE I

ANALYSIS OF POST OPERATIVE CHEST COMPLICATIONS WITH VARYING ANAESTHETICS

Anaesthetic.	Number of Cases.	% of severe chests.	% moderate.	% slight
N20, 02. Ether.	85	14.1%	16.5%	30.5%
Pentothal. N20. 02.	69	8.1%	8.1%	33.5%
Local anaesthesia.	68	11.8%	10.2%	22.0%
30 grains chloral hydrate, plus local anaesthesia.	46	10.9%	2.9%	30.8%

In lucas' investigations, "severe chests" were classified as those associated with pyrexia, cough and lasting for more than five days, "moderate" lasted three to five days, and "slight" were those where there was cough, mild clinical signs in the chest, temperature below 100 and clearing in under three days.

Moderate and severe cases he stated were due to atelectasis either diffuse or lobar, the former being the more common, and appearing within thrity-six hours of the operation. First symptoms being a dry cough and temperature of 99 to 101. Pulse and respiration rates are both raised and there is vague discomfort in the chest. At this stage there are no clinical signs in the chest other than slightly diminished breath sounds at the bases or a few subcrepitant rales on auscultation.

Twenty-four hours later the temperature is still elevated and thick sputum appears which rapidly becomes purulent. Fine rales are heard at all areas of the chest and areas of consolidation may be detected. At this stage there is generally breathlessness.

Lobar atalectasis is less common but more severe, and pain and breathlessness are more marked. There is often some cyanosis, and examination of the chest shows all the signs of a collapsed lobe with diminished movement, dullness and diminished or absent breath sounds. The condition is often on the side of the operation. The temperature rises for two days up to 102 to 103 and then rapidly resolves. The sputum is purulent and may be rusty.

Locas found the results of chemotherapy to be poor. The temperature was generally lowered, but the chest signs remained and the effect of chemotherapy was to increase the duration of the disease. He considered the cause of the atelectasis to be partial fixation of the diaphragm as a result of muscle spasm at the site of the operation. This relationship between the flat muscles and the diaphragm has already been indicated.

Churchill and McNeil [3] have also described the reduction in vital capacity associated with abdominal operations, and related the degree of this reduction with the various incidences/

incidences of post operative chest complications for different operations. The reduction in vital capacity and comparative immobility of the diaphragm are the main factors in causing these post anaesthetic chests, and these are not due primarily to the type of anaesthetic used, but to the fact that there has been an operation involving incision through the muscles of the abdominal wall with later muscles spasm owing to pain. The fact that the peritoneum has been interfered with is also of some significance. It is interesting that the incidence of such chest conditions after operations for hydrocele and varicocele is very much lower than that for inguinal herniae.

In a small series of fifteen varicoceles and twenty-five hydroceles operated upon in soldiers by myself, by an inguinal incision there were no post operative chest complications. The anaesthetic and premedication were as for hernia repairs, and yet, in a series of 47 simple herniotomies in soldiers, with the same incision, there were 11 chest complications of various degrees. Most were mild or moderate, though two were severe. These facts would suggest that stimulation of the peritoneum may play some part in the etiology of these post operative chest complications, and that factors other than the anaesthetic are at work.

It is suggested that the best method of treatment is mechanical, aiming at expanding the lung bases and promoting effective/

effective aeration of all pulmonary tissue. This can be readily done by the routine administration of carbon dioxide after operation, for five minutes every hour through a suitable mask or nasal catheter.

In my own experience, the incidence of post hernial chest complications was substantially reduced after introducing this refinement as a routine item in the immediate post operative treatment of all herniae.

Twenty-five per cent of all cases which require one and a half hours or over of anaesthesia develop some form of chest complication. In herniotomy and repair, this should be an exceptional occurrence, even in bilateral cases, but it may be definitely stated that the longer the operating time, the more likely chest complications will be to follow.

There is no general reduction of "chests" after using local anaesthesia, pentothal, chloroform, ethylene, or trilene. Spinal anaesthesia in my experience is no better, and the only procedure I am familiar with which will reduce the incidence of chests is the routine use of carbon dioxide. This is also the experience of Lucas.

Ethylene [4] according to Coley is the best anaesthetic because it is associated with little post anaesthetic vomiting. One disadvantage however, is that it is technically more difficult to administer, and thus may not be ideal for routine use.

Local anaesthesia is indicated for all cases of strangulation. [5. 6. 7.] This type of operation is quite different from ordinary repair, and generally consists only of freeing the constricting ring, and reducing the strangulation. It may also be conveniently used in simple excision of the sac without plastic repair. [8. 9.]

Indications for Local Anaesthesia. In selecting the anaesthetic for a hernia operation, the life of the patient is always the first consideration. The local method is sometimes condemned because it takes too much time. While anaesthesia by the infiltration method often requires more time than general anaesthesia, this is not ~~as~~ so with the regional method. There the field of operation can be completely blocked in less time than may be required to secure relaxation with general anaesthesia.

It may be used for nonstrangulated and strangulated inguinal and femoral hernias, and for many of the umbilical and ventral varieties.

When the patient is handicapped by old age, shock, cardiac, renal or pulmonary lesions, the local method is ideal, and carries with it a lower risk than inhalation anaesthesia.

Advantages of Local Anaesthesia Every step in the operation carried out under a general anaesthetic, can be done with

a/

a local. In strangulation local anaesthesia is a safeguard against shock. If intestinal resection is necessary, it can be performed without added risk to the patient.

Extreme old age, organic disease of the cardio-vascular system, lungs or kidneys, were formerly believed to be contraindications to the radical operation for nonstrangulated hernia. Watson states that with a good technique, there is practically no contraindication to the cure of every hernia, regardless of age of the patient.

Contraindications Many patients prefer to be asleep during the operation. In my view a more ideal relaxation can be had by general anaesthesia, and, as this is essential for the whole skin graft method I do not favour local anaesthesia for this purpose.

Local anaesthesia is also usually contraindicated in children and neurotic subjects when the hernia is not strangulated.

Anaesthetic Agents 1. Cocaine Cocaine hydrochlorate was the first drug used to produce local anaesthesia. It gives an immediate and longer anaesthesia than the safer substitutes, but it is too dangerous for general use. Cocaine is not only very toxic, but many patients have an idiosyncrasy for it, and for this reason it should never by employed in hernia operations. However, if no other anaesthetic is available for an emergency/

emergency operation, cocaine can be used in a 0.1 per cent solution to which epinephrine (adrenalin, suprarenin) has been added, 2 minims of epinephrine solution (1:1,000) to each ounce (30 c.c. or mils) of the anaesthetic solution. No more than 4 ounces (120 c.c. or mils) of this solution should be used in the course of an hour, and not more than one ounce (30 c.c. or mils) should be injected in a fifteen-minute period. The margin of safety is greatly increased by using a 0.1 per cent solution. Four times as much cocaine in a 0.1 per cent solution can be injected with safety as when a 1 per cent solution is used. (Watson).

2. Novocaine Novocaine or procaine is the most generally used local anaesthetic. It is about one-seventh as toxic as cocaine, and a relatively large amount of a 0.2 per cent solution can be injected without danger of toxic symptoms. One-half per cent solution is used for the skin and nerve trunks and 0.2 per cent solution, elsewhere. It is advisable to add 2 minims (0.12 c.c. or mils) of adrenalin hydrochloride (1:1,000) to each ounce (31 c.c. or mils) of the novocaine solution. The novocaine must be sterile, and dissolved in sterile normal saline. The solution must be freshly prepared for each operation.

To Prolong the Anaesthesia The ordinary anaesthetics do not give an analgesia that lasts long enough for the average hernia operation, and it is necessary to add a substance to prolong the anaesthesia period.

1. Adrenalin Adrenalin (epinephrine, suprarenin), is added in the proportion of 2 minims (0.12 c.c. or mil) to each ounce (30 c.c. or mils) of the anaesthetic solution, prolonging analgesia for thirty to sixty minutes, depending on the anaesthetic selected and the strength of the solution. There is ample time to complete the ordinary hernia operation before sensation returns.

Toxicity of Local Anaesthetics All local anaesthetics are toxic if a sufficient amount be used. Several factors govern the toxicity; the age and general condition of the patient, his personal idiosyncrasy to the drug, the concentration of the solution, the rapidity of absorption, and the kind of tissue injected. The more vascular the tissue the quicker the absorption. Accidental injection into a blood vessel may result in death. This accident should never occur if only a small amount of the solution be injected at one time; the injection made slowly,and the needle kept moving while infiltrating the tissues.

Technique of the Injection The anaesthetic solution should be freshly prepared and injected at body temperature. With expert technique the operation is painless. Patients may fall asleep during the latter part of a tedious hernia operation, especially after the peritoneum has been closed.

Success depends upon patience, knowledge of the sensory nerve distribution, and skill in the method. The rapidity, depth/

depth and duration of anaesthesia depend on the substance used and the strength of the solution. The operation must not begin until anaesthesia is complete, usually five to ten minutes after injection.

Delayed Wound Healing Sloughing after local anaesthesia is due to too extensive infiltration of the tissues, the use of nonsterile or nonisotonic solutions, or to too much epinephrine in the anaesthetic solution. It is predisposed to by devitalised tissues, debility and old age.

SPINAL ANAESTHESIA

Spinal anaesthesia is given warm support from Harris [10] and Kelly [11], but it also has no associated or compensatory reduction in the incidence of post anaesthetic chests.

The ideal anaesthetic should be pleasant to take, have no unpleasant after effects, give ideal muscular relaxation, be entirely non-toxic, be safe to give, even in inexperienced hands, and economical to produce. In the absence of this substance it is difficult to improve upon ordinary gas oxygen and ether for routine hernia work at the present time.

The important points are that post anaesthetic chests should be avoided if possible by routine use of carbon dioxide inhalations to promote lung expansion, and secondly, muscular relaxation must be complete. This is especially so for the whole skin technique.

General anaesthesia is also preferred by Cowell [13].

In conclusion, it may be said that the choice of anaesthetic does not affect the recurrence rate. Edwards [12] quotes a series of cases with recurrence rates of 7% with general anaesthesia, 7.5% with spinal and 5% with local.

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CHAPTER 5

ECONOMIC AND LEGAL SIGNIFICANCE OF HERNIAE

Incidence of Hernia In America, 6000 persons die from strangulation of inguinal herniae, and 160,000 operations for repair are performed annually. It has been calculated that the loss to industry in the U.S.A. due to hernia absenteeism amounts to £30,000,000 per annum. [1].

In America also hernia is the most common single cause of industrial litigation, and, according to Jameson and Cantala [2], the average cost of a herniotomy plus loss due to absence from work was in 1930, to the average patient, no less than £145.

In this country, in view of sick benefits the cost to the patient is less, but even so, there is a minimal absence from work of eight to twelve weeks, depending upon the nature of the work, and a consequent heavy loss of man power hours.

Brandenburg examined 3810 workmen employed in digging the St. Gothard tunnel and found that 3.81% had hernia, whilst 80.2% had a "predisposition to hernia as evidenced by patent inguinal rings." [8]

In Germany, based upon an extensive analysis of Prisoners during the 1914-1918 War, out of 1511 civilians, 3.55 per cent suffered from hernia, and, in 20,000 servicemen 2.43 per cent had one or more inguinal herniae [4]. In another series/

series reported by Schwiening [9], out of 1,252,795 men examined for Military Service 15.75% had hernia. Zollinger [10] examined 4836 labourers and found that 4.7% had incomplete herniae and 2% fully developed herniae. During the present War, it has been a matter for surprise how many young men have required treatment for hernia shortly after joining the Services. In one camp, 1300 recruits were admitted in July 1941 and of these, 143 had herniae, whilst in one 600 bedded military hospital, 634 operations for herniae were done between March 1941, and October 1942. These figures give some indication of the frequency in this country and during the present War.

Edwards discussed this in detail in his paper [3]. but was unable to give a figure for the incidence of hernia amongst recruits entering the Services. The incidence however, was high. So many men were sent off duty, and with the results of surgery, carrying a recurrence rate of not less than twelve per cent. in 1944 a rule was made by the Army that no soldier was to be subjected to operation for hernia unless the condition occasioned him very definite trouble. The operation was not to be undertaken for symptomless cases. This state of affairs is on a par with that in the American Army at the end of the 1914-18 European War. No man was then permitted to have an operation for hernia after entering the army, unless the condition was proven to be the cause of symptoms, and when operation was indicated it was only performed by someone with a background of mature experience in surgery. [5].

Akerman [11] in 1914 reported 4000 operations annually for hernia in Sweden, and stated that 700,000 men are examined under the compensation laws. In his wide experience he saw only 130 cases of true traumatic hernia.

In America today, certain insurance companies will accept as a good life risk a person with an inguinal hernia, provided they give an undertaking to wear a truss and not to have an operation of election for its relief.

These facts are a striking criticism of the attitudes of two large organisations, namely insurance companies, and the Army, to the results of surgery, in so far as hernia is concerned at any rate.

In France, Berger [6] has stated that one person in every sixteen born will develop hernia.

It thus becomes evident that the high incidence of hernia, the conflict of views as to the results of surgery, and finally the question as to the influence of trauma in determining the onset, combine to make the question one of considerable economic importance.

The frequency of litigation arises from claims made by patients that their hernia was the outcome of strain sustained while at work.

The effect of repeated strains at work is discussed in later sections, but it cannot be denied that these minor traumata may play an important part/

part in determining the ultimate development of the condition. It is also accepted that a very small minority are due to severe trauma and develop almost immediately after receipt of same.

The attitude in the courts is now that the condition is usually due to the presence of a preformed sac, and that no employer is liable to damages where an employee develops a hernia unless the employee can prove that the condition is essentially traumatic in type.

Traumatic Hernia In Germany the Courts hold that traumatic hernia to be diagnosed must conform to the following conditions.

(1) The relationship to accident must be proven by examination made within 48 hours.

(2) Examination must prove that the hernia appeared suddenly.

(3) It must have appeared immediately after the accident and be associated with pain.

(4) The claimant must prove that he had no hernia prior to the accident.

Similar regulations govern the diagnosis in Switzerland and Sweden, America and Britain. Rare though the condition may be, it is recognised and examples have been published by many people including Akerman [11], Binda and Morisani [13].

In 1929 the American Railway Association [7] laid down the criteria of traumatic hernia.

They claimed that to be traumatic in origin the hernia must conform to the following requirements:

1. Descend immediately after the accident.
2. Not to have been present before the accident.
3. Be associated with severe pain at the site.
4. Compel the patient to cease work at once.
5. Oblige the patient to seek medical attention as soon as practicable.

Finally, they declared that the employer must be notified within twenty-four hours of the development of the condition, and that the patient must co-operate in the treatment of it.

Cases which conform to these rules are given full compensation. Other cases developing in the course of duty are regarded as a disease due to some special anatomical weakness on the part of the patient, and the Railway Companies dissociate themselves from onus of responsibility.

As confirmatory, though not positive evidence against a traumatic hernia are to be considered.

1. The presence of a hernia on the other side.
2. An enlarged ring on the other side.
3. An ectopic testis relating to the hernia.
4. The fact that the claimant may have done heavy work over a period of years.
5. Advanced age.
6. If at operation there is no evidence of tissue damage and the sac is thick, fibrotic, or relating to old adhesions.

A proportion arise for consideration, where at a previous and recent medical examination performed during their term of employment, there was found and noted, no anatomical weakness in the inguinal canals, and yet where hernia developed later and/

and strain at work is considered by the patient to be an important contributing factor in its etiology. Some benefit is usually paid under these circumstances.

Aggravation of a Pre-existing Hernia Proof of aggravation of a pre-existing hernia is recognised in many States in America and in Britain. English Law states "where a strain causes protrusion of the bowels that is a compensable injury" even though the hernia is at a point weakened by congenital malformation or pre-existing hernia. To establish aggravation the following points are involved.

(1) The patient should localise the accident in time and place and report it immediately.

(2) There must be immediate pain in the affected part, compelling claimant to cease work.

(3) There must be a hernia present immediately after the injury.

(4) The accident may be due to physical exertion, strain or impact.

As opposed to the Railway Companies, the Insurance Companies however, adopt the attitude that all hernias are due to a preformed sac excepting the small traumatic group, and only to this small minority is compensation paid.

Many American Industrial Companies have realised that hernias are such a potent source of absenteeism that they make it a rule that a man found to have a hernia must be operated upon, and the firms assume the cost of the operation. From a standpoint of efficiency Mock [12] says that a man with a/

a hernia is approximately 25% less efficient than a man without one. The average cost of operation to these firms is stated to be £15.

Potential Hernia and Loose Inguinal Rings Many firms requiring physical examination of employees refuse any applicant with patulous inguinal rings. If a person with such defects is employed by a firm not demanding physical examination, he is on occasions liable to dismissal in the event of such physical examination being enforced.

Frequency of Open Rings and Hernia

Colcord [14] sent out questionnaires to surgeons in industrial surgery. One hundred answers, covering about 500,000 examinations, were complete enough to be of value. The more important answers were summarized as follows: 20 per cent of the surgeons examined applicants for hernia before employment. Of those examined, 10 per cent had open inguinal rings and 2 per cent had hernias. Twenty per cent of the surgeons who replied, believed that every open ring was a potential hernia, and 90 per cent of them believed hernia was due to a congenital defect. Only 2 or 3 cases of traumatic hernia were reported.

Medicolegal Responsibility in the Treatment of Hernia The legal responsibility of a doctor in the treatment of hernia is as in all other aspects of general surgery [15. 16.], and the reader/

reader is referred to special papers for detailed information.

Affidavit in Case of Atrophied Testicle

Claverley [17] advised a routine examination of the testes prior to all hernia operations. If the testicle on the side of the hernia is found diseased, the patient should be asked to sign a form to that effect as a safeguard against litigation.

INJECTION TREATMENT

The injection method is rapidly becoming an accepted method of treatment for selected cases of reducible hernia. In Minnesota nearly 90 per cent of all industrial hernia claims that are approved by the Industrial Commission are awarded the injection treatment. [18].

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C H A P T E R 6

ANATOMY OF THE INGUINAL CANAL

EMBRYOLOGY

It will be remembered that in the earliest phases of embryonic growth, the embryonic area is nearly circular and devoid of distinguishing features. One of the first signs of activity is indicated by the appearance of a linear opacity in the midline of the area, which, concomitant with this event, assumes a pear shape, indicating the long axis of the body, Fig. 6. This opacity is known as the primitive streak, and the cephalic end of this line is termed the primitive node. Two embryonic layers can at this stage be identified, ectoderm and entoderm. From the sides of the primitive node and cephalic extremity of the primitive streak, a period of intense growth is manifested, with migration of cells laterally, to extend over the entire embryonic area excepting the median plane. These cells infiltrate between the two primary layers of ectoderm and entoderm, and form a third layer, designated secondary mesoderm.

This secondary mesoderm arranges itself in a thicker mesial strip, paraxial mesoderm, lateral to the neural groove, lateral to that a narrowed portion termed "the intermediate cell mass," and external to that in turn, a flattened portion known/

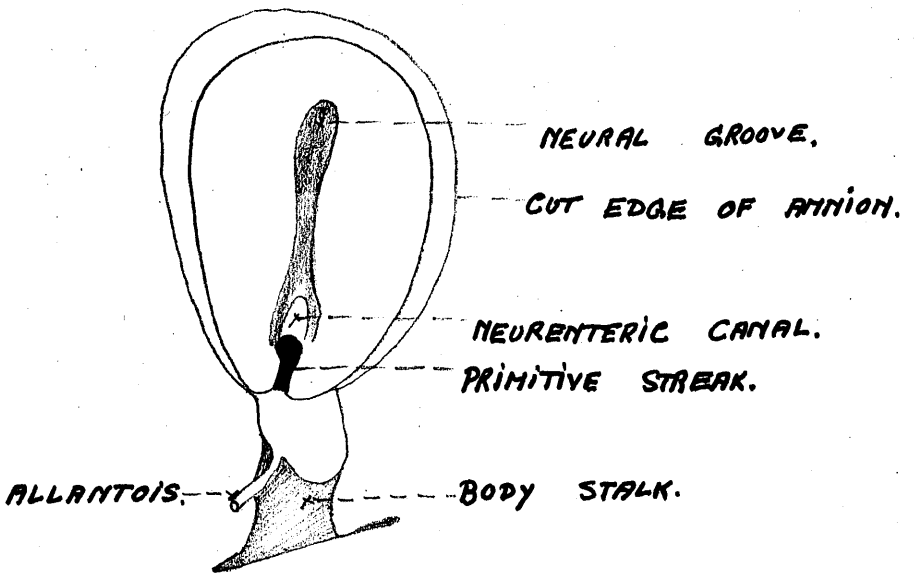


Fig. 6
OVOID EMBRYO AND PRIMITIVE STREAK

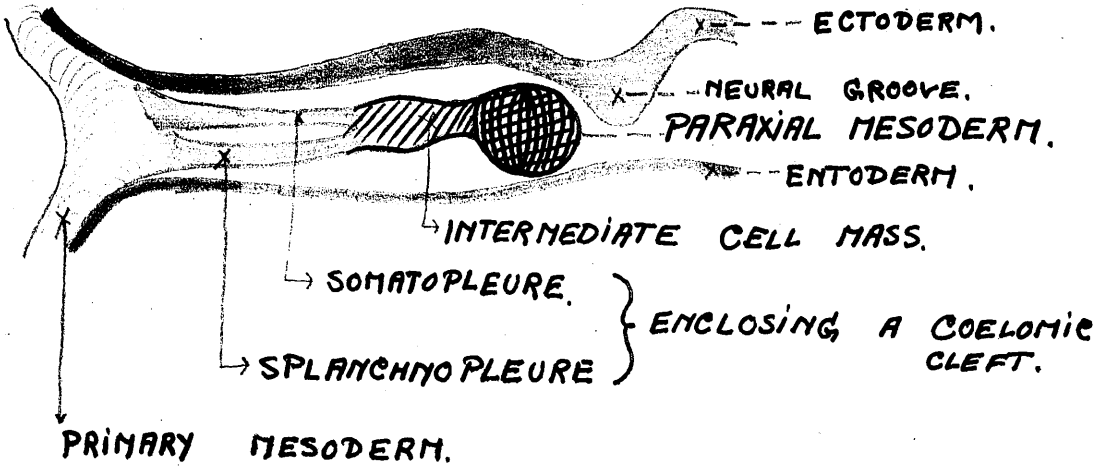


Fig. 7
PARAXIAL MESODUM

known as the lateral plate. Fig. 7. The paraxial mesoderm, during the late third or early fourth week, becomes subdivided into a series of cubical blocks by a number of transverse grooves. The divisions of paraxial mesoderm so formed are known as somites or metameres. Each of these somites at first contains a central cavity, or myocele which becomes filled with fusiform cells, and the cells of the dorsi-lateral portion of the somite constitute the myotome from which will arise the muscle plate supplying all the straited muscle of that segment.

This process of segmentation of the mesoderm progresses until at least thirty-five pairs of segments have been formed, and though it has not so far been demonstrated, it is assumed that the other structures of the embryo are likewise segmented, in view of the arrangement of the nerves of the spinal medulla, ectodermal in origin.

Each myotome so formed, divides longitudinally into a dorsal and ventral portion. The former is innervated by the posterior ramus of the appropriate spinal nerve, and located on the dorsi-lateral aspect of the vertebral body. The latter becomes innervated by the anterior ramus, and the cells of this group migrate ventrally into the body wall, or somatopleure. The nerve supply of each of these subdivisions is determined at a very early age, and the cells carry their nerves with them as they migrate. This is the basis of growth/

growth and innervation of the flat muscles of the abdominal wall, and of the intercostal groups also. It should be mentioned that the mesodermal cells are early differentiated into those which retain their close packed character, mesoderm proper, and those which form a loose tissue with a fluid matrix - mesenchyme. Connective tissues are mesenchymal in origin. Muscles derive from mesoderm proper.

The involuntary muscles are derived from the mesoderm of the splanchnopleure. The term "splanchnopleure" is given to the entoderm with adjacent entodermal layer of mesoderm derived from the lateral plate. Fig. 7. Involuntary muscle is derived from the mesoderm of the splanchnopleure, and develops in situ.

Many of the derivatives of the myotomes may disappear, degenerate, or be converted into fibrous tissue, and this may be identified later as aponeurosis or ligaments.

The prime event of importance in the development of the inguinal canal in the male, is the journey through it, of the testicle, en route for its resting place in the scrotum.

At first, the testicle lies on the posterior abdominal wall, but, with degeneration of its cephalic end, it assumes a more caudal position, and is attached to the mesonephric fold by a fold of peritoneum called the mesorchium. The mesorchium contains the testicular vessels and nerves, together with a variable/

variable quantity of undifferentiated mesenchyme. It also attaches itself to the anterior abdominal wall by a fold of peritoneum called the inguinal fold. The mesenchymal cells included in this fold, form a band from the primitive scrotum skin through the inguinal fold and the mesorchium, to the lower pole of the testis. This cord later gives origin to the fibromuscular bundle called the gubernaculum testis. Fig. 8.

The inguinal canal forms around the gubernaculum as the muscles of the anterior abdominal wall become differentiated.

At the end of the eighth week, the lower part of the anterior abdominal wall is horizontal, but later it assumes a more vertical posture with the return of the intestines into the peritoneal cavity. As a consequence of these changes, the umbilicalartery retracts a crescent shaped fold of peritoneum which runs from behind forwards, forming the medial wall of a recess into which the developing testis protrudes. The lower, or caudal end of this recess lies along the inguinal canal in relation to the gubernaculum, forming the processus vaginalis.

The internal ring is in relation to the lower pole of the testis till the seventh month when the testicle traverses the inguinal canal to reach the scrotum. As it makes this journey, it is of necessity, accompanied by its peritoneal covering, and the adjacent parietal peritoneum of the iliac fossa is

also/

also drawn down as the processus vaginalis. Fig. 9. The portion of the processus vaginalis relating to the testis is known as the tunica vaginalis testis, and the peritoneum between that and the abdominal cavity relating to the spermatic cord and inguinal canal becomes progressively obliterated. [1.] Fig. 10.

In the female subject, the prolongation of the peritoneal sac which in the male becomes the processus vaginalis, also traverses the canal in relation to the round ligament of the uterus, and is known as the Canal of Nuck. This is normally obliterated before or shortly after birth.

The essential features therefore of the development of the inguinal canal are the descent of the testicle through it, the formation of the canal around the gubernaculum testis, the protrusion of the processus vaginalis through the canal to the scrotum, and finally the obliteration of the processus between the testicle and the internal abdominal ring.

The precise nature of the occlusion should be considered, and also the chronology of testicular descent.

PROCESSUS VAGINALIS

This normally becomes occluded first at the level of the internal ring, and secondly, just above the testis, these constrictions being apparent shortly after birth.

The caudal portion of peritoneum relating to the testis remains/

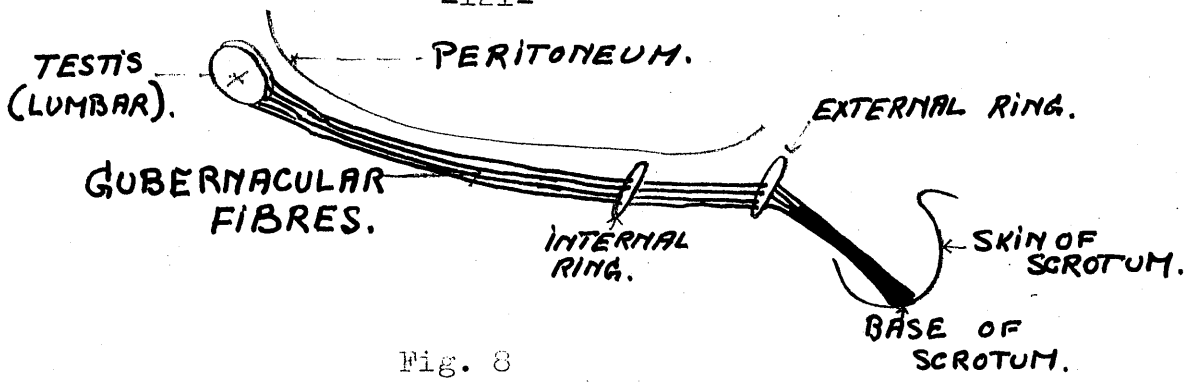


Fig. 8

GUBERNACULUM TESTIS

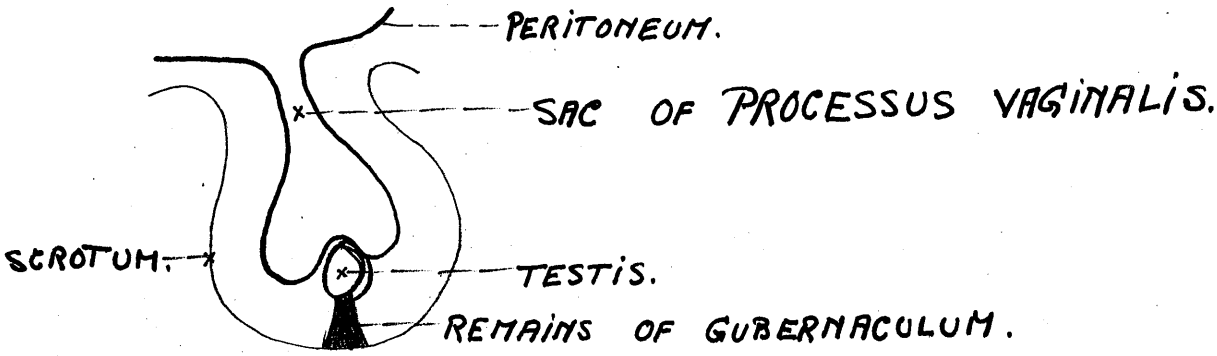


Fig. 9

PROCESSUS VAGINALIS

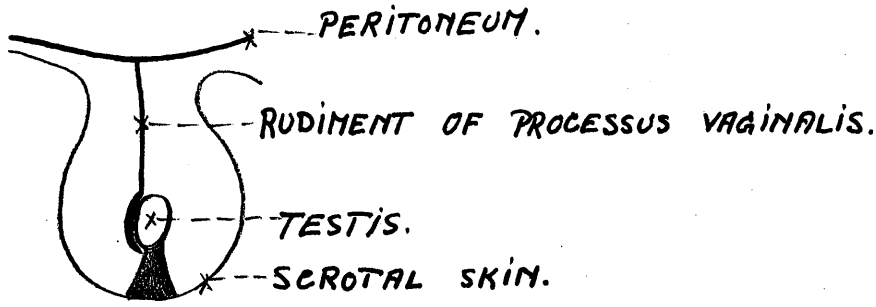


Fig. 10

OBLITERATION OF PROCESSUS VAGINALIS

remains as the tunica vaginalis testis, but the sac between the two points obliterates to form a fibrous cord, described as the rudiment of the processus vaginalis. Fig. 10.

The applied importance of these phases of development relate to the future growth of hydrocele or herniae. The following types of anomaly may be observed: Fig. 11.

1. Vaginal or Congenital Indirect Inguinal Hernial Sac
   Here, the processus fails to obliterate at any point, and a free communication exists between the abdominal cavity and the interior of the scrotum on the affected side.

2. Funicular.
   This term is given to the process of peritoneum which becomes caught as a diverticulum of the main processus vaginalis and lies between the muscle layers of the developing abdominal wall. This type of process may have one of several relationships:
   (a) Properitetal; that is to say, superficial to the external oblique muscle.
   (b) Intramuscular - between the internal and external oblique muscles.
   (c) Retro-parietal, where the sac lies between the peritoneum and transversus abdominis or fascia transversalis. The position found depends on how and where the diverticulum is attached to the developing muscle layers.

4. Infantile Hernial Sac
   Here, the processus is obliterated above the testis, but a process or diverticulum of peritoneum is found anterior to a funicular sac.

5. Encysted Hernial Sac
   Here, there is a congenital type of sac, with in addition, a second process of peritoneum lying in front of the congenital sac up to the external ring.

These last two types, the encysted and the infantile, owe their origin to a diverticulum of the processus vaginalis being caught/

caught by, or attached to, the external abdominal ring during the intricate processes of development.

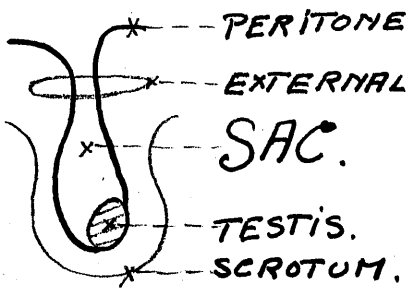
CHRONOLOGY OF TESTICULAR DESCENT

During the third month, the organ is found in the iliac fossa, and between the fourth and seventh months, it remains at the level of the internal abdominal ring. In the seventh, it traverses the inguinal canal to lie, during the eight month, subcutaneously at the external ring. Finally, in the ninth, it reaches the scrotum and terminates its journey to the scrotal base either then or shortly after brith. Fig. 12.

It follows that occlusion of the peritoneum above the testis, usually taking place at or after birth, a very large proportion of people are born with a sac of peritoneum extending through their inguinal canal to a greater or lesser extent. Banerjee [4.] claimed that in normal children, 59% have patent peritoneo-vaginal processes during the first four months of life and 44% during the fifth month. This may persist throughout life, and Keith [2.] states that the incidence in old people is 120 per 1000 subjects. Row quoted by Hughson [3.] found 47 per 200 persons examined. Murphy [5.] states that 35% of three-year-old infants have congenital hernial sacs.

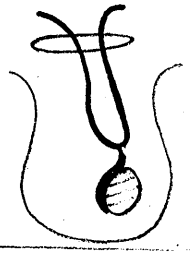
In others, the sac is obliterated, or else one of the anomalies of development may persist, and render probable the extrusion of a hernia at a later date.

I.



CONGENITAL
VAGINAL.

II.



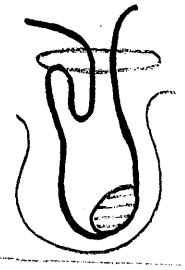
FUNICULAR.

III.

A DIVERTICULUM OF TUNICA OR PROCESSUS LYING ANTERIOR TO A FUNICULAR SAC.

INFANTILE.

IV.



A DIVERTICULUM OF PERITONEUM LYING ANTERIOR TO A VAGINAL SAC.

ENCYSTED.

V.

INTERSTITIAL.

Fig. 11

FIVE DIFFERENT VARIETIES OF HERNIAL SAC

There may be abnormalities associated with testicular descent and certain of these have an application to the subject of inguinal hernia.

The testis normally descends to the scrotum but it may be found outwith the scrotum, though lying in the normal path, somewhere between the pelvis and external ring, or alternatively in an abnormal site, due to an abnormal pull from one of the gubernacular tails deviating the organ out of its narrow normal path. [6].

The gubernaculum attaches between the skin of the developing scrotum and the lower pole of the testis with related peritoneum and the testis lies posterior to this peritoneal process. [7]. Where the testis is, there must also be the related peritoneal protrusion, and where the organ is imperfectly descended a congenital hernial sac lies beside it. This does not have a practical application to the lumbar variety of incompletely descended testicle, but does to the iliac, inguinal and scrotal types where the organ has passed through the internal ring, but failed to reach the base of the scrotum. It may be remarked here, that the testis which has deviated from the path of normal descent, designated by ectopia testis, is normal in development, contrasting with the imperfectly descended organ which is usually smaller and atrophied.

SURGICAL ANATOMY OF THE NORMAL INGUINAL CANAL

Anatomy forms the foundation upon which any operation must depend, and it is of importance to the surgical treatment of herniae that the anatomy and function of all the structures going to make, and relate to, the inguinal canal, should be considered.

THE INGUINAL CANAL

The inguinal canal is a channel, one and a half inches long lying obliquely in the abdominal wall, parallel to and a little above the medial aspect of the inguinal ligament. It contains, in the male, the spermatic cord with its contents and the ilioinguinal nerve; in the female, the round ligament of the uterus.

At its lateral extremity, is the abdominal internal ring, and at its medial, the external abdominal ring. These terms have been criticised on the grounds that the openings are not rings, but triangles, that they are not abdominal but inguinal and that the external is really superficial and the internal lateral. It is thus suggested that they should be described as the lateral inguinal orifice, and the superficial inguinal orifices respectively.

The canal slants obliquely down from lateral to medial, and is related in front throughout its entire length, from superficial/

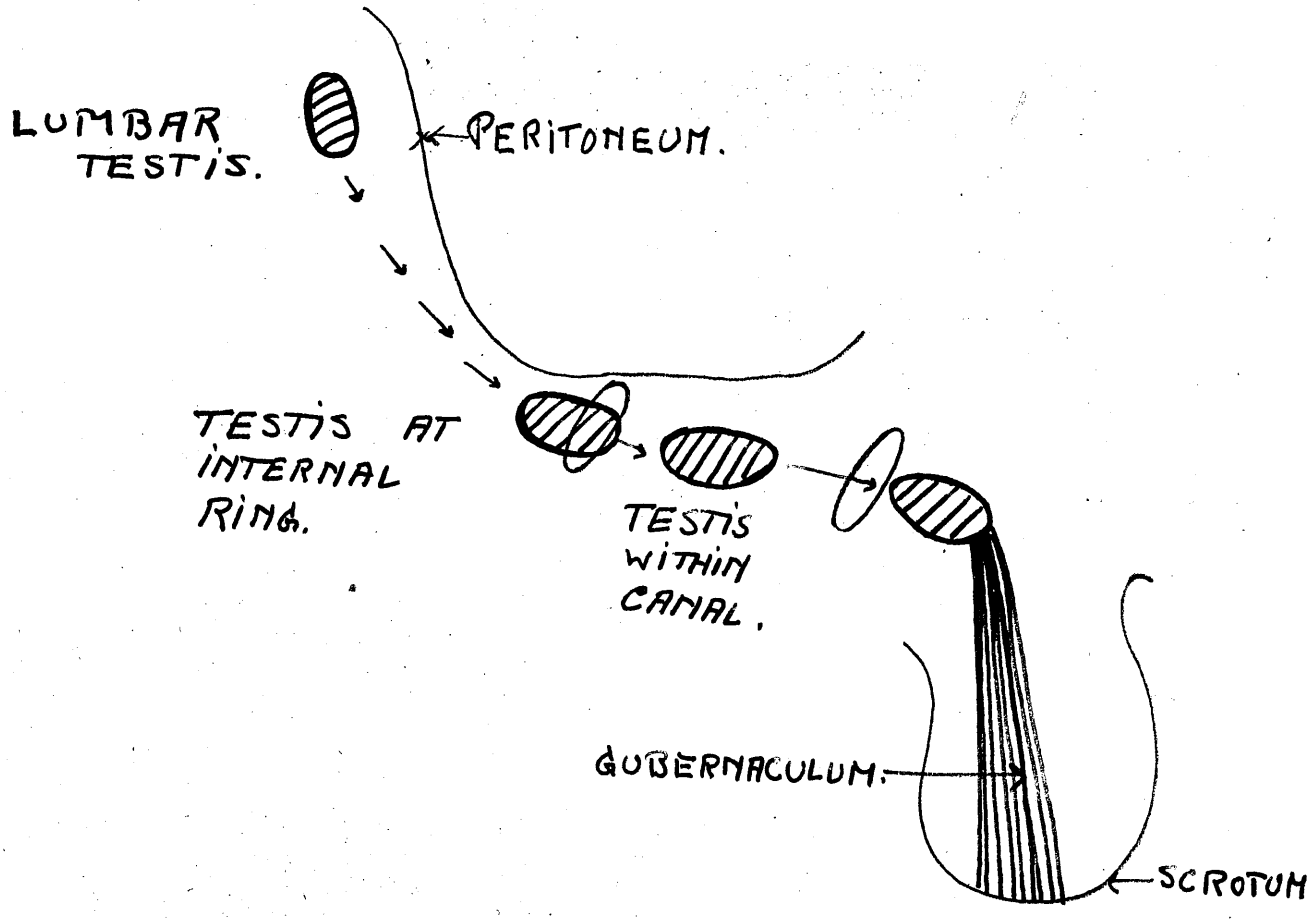


Fig. 12
STAGES IN DESCENT OF THE TESTIS

superficial to deep, to skin, superficial fascia, aponeurosis of external oblique, and, in the lateral third, to the fleshy fibres of origin of the internal oblique muscle. Posteriorly, the relations are the reflected inguinal ligament, the conjoined tendon in the medial third, and posteriorly transversalis fascia, extraperitoneal areolar tissue and peritoneum. Below, are the lacunar ligament medially, and the union between the inguinal ligament and fascia transversalis, whilst above are the arching fibres of the transversus abdominis and internal oblique muscles. Fig. 13-15. The canal has an oblique disposition, and, in the child, effects a more direct penetration of the abdominal wall than in the adult. The internal abdominal ring is circular in shape, and located one half inch above the mid point between the anterior superior spine and the symphysis pubis. It is an opening in the fascia transversalis lateral to the deep epigastric vessels.

The superficial inguinal ring This is traingular and located above and lateral to the crest of the pubis. Its margins are formed by arching fibres of the external oblique, emerging from the inferior aspect of which is the spermatic cord, lateral to the pubic spine. [8].

The spermatic cord The cord is formed as a result of the descent of the testis into the scrotum. During descent, the organ drags it its wake, its vessels, nerves, and duct, the

vas/

vas deferens. These structures are enclosed by three layers of fascia arising from the three layers of the abdominal wall and pushed before the advancing testis. They are the internal spermatic, or infundibuliform fascia derived from the fascia transversalis, the cremasteric from the internal oblique and finally, the external spermatic or intercrural fascia from the external oblique muscle and prolonged down from the pillars of the external abdominal ring along the cord.

Of these three coats, the cremaster is the most important, and is composed of muscle fasciculi united together by areolar tissue to form the cremaster muscle.

The spermatic cord is composed of arteries, veins, nerves, lymphatics, and the vas deferens, connected together by areolar tissue and enclosed in the three fascia-muscle coverings. The arteries are the testicular, the external spermatic, and the artery to the vas. The testicular is a branch of the abdominal aorta and traverses the entire length of the inguinal canal to supply the testis, anastomosing in its terminal part with the artery to the vas. It nourishes the substance of the testis and part of the epididymis.

The external spermatic or cremasteric artery supplies the coverings of the cord, is a branch of the superior vesical, and ramifies in the wall of the vas, terminating by anastomosis with the testicular artery near the epididymis.

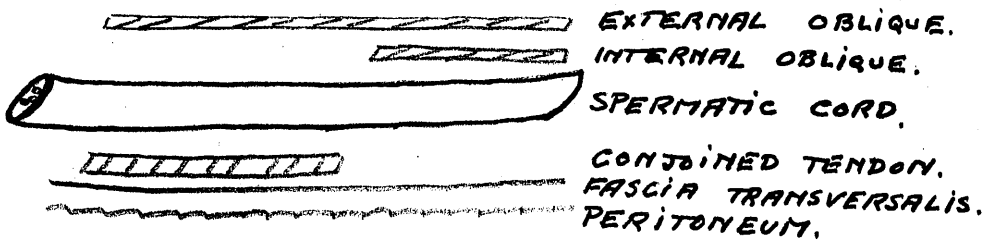


Fig. 13

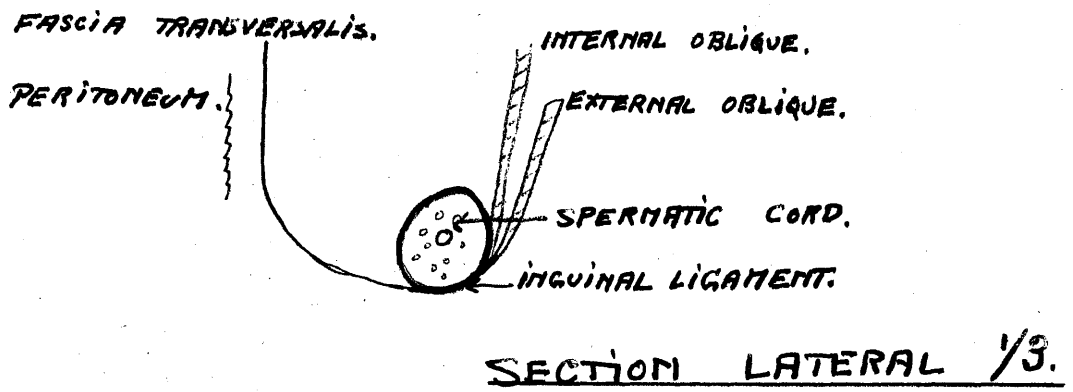


Fig. 14.

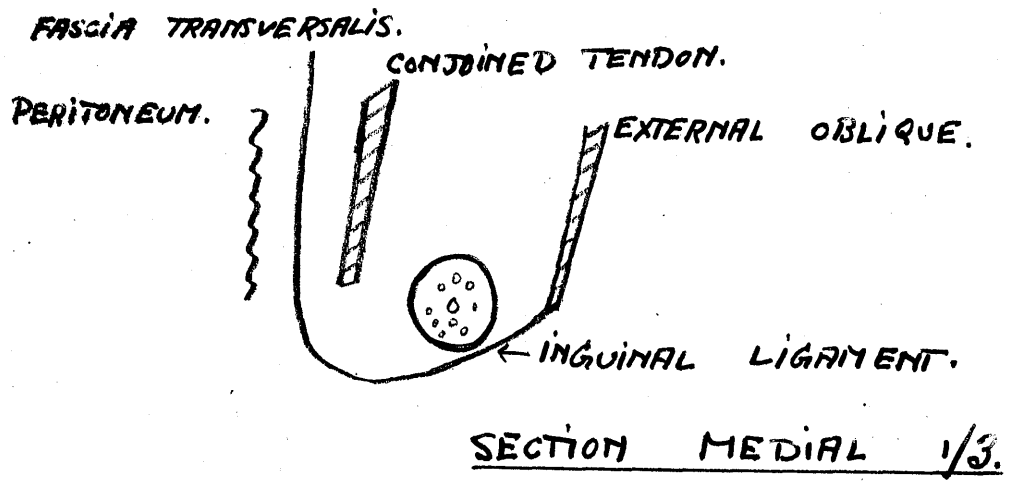


Fig. 15

RELATIONS OF INGUINAL CANAL

The venous return is via the pampiniform plexus formed by tributaries emerging from the back of the testis and the epididymis. They form a substantial plexus occupying a large part of the cord and located anterior to the vas. Internal to the internal abdominal ring they form two main trunks, which in turn unite to open as one channel into the inferior vena cava on the right side and the renal vein on the left.

The nerves are the external spermatic branch of the genitofemoral and the spermatic plexus of the sympathetic which accompanies the artery to the vas.

The spermatic cord enters the scrotum deep to the fasciae of Scarpa and Colles.

One other structure remains to be mentioned, which, though not an immediate relation of the inguinal canal is intimately connected with the muscles forming it, the rectus abdominis muscle and its sheath. The three flat muscles of the abdominal wall fuse medially with the sheath of the rectus and the nature of their insertion into the lower extremity of the rectus is of importance.

Of these anatomical structures mentioned, almost all relate to one or other aspect of the etiology, progress, pathology or treatment of inguinal hernia.

THE FLAT MUSCLES OF THE ABDOMINAL WALL

These are the internal and external oblique, and the transversus abdominis.

EXTERNAL OBLIQUE

This is the most superficial of the three flat muscles of the abdominal wall.

Origin

It arises by eight fleshy slips from the outer surfaces and inferior margins of the lower eight ribs, interdigitating with the slips of origin of the serratus anterior and latissimus dorsi.

Insertion

The muscle fibres direct downwards and forwards to various attachments. Those from the lower two ribs pass nearly vertically downwards and insert into the anterior half of the outer lip of the iliac crest; the middle and upper fibres sweep forwards and downwards to merge into an aponeurosis which is thin but very strong. This aponeurosis blends with its fellow of the opposite side along the midline and forms part of the anterior layer of the sheath of the rectus abdominis. Abvoe, it gives origin to the lower fibres of pectoralis major, and below, its fibres extend obliquely across from the anterior superior iliac spine to the pubic tubercle and pectoneal line.

The fusion of the aponeurosis in the mid line assists in forming the linea alba, extending as a tendonous raphe from the zyphi sternum to the symphysis pubis.

Inguinal Ligament

That part of the muscle extending between the pubic tubercle and anterior superior iliac spine forms a powerful band which is folded inwards in such a fashion as to unite and continue, below with the fascia lata, and, in its upper and deep aspect, with the fascia transversalis. Medially, a small portion is reflected to attach to the pecten pubis and is called the lacunar ligament. From this, some fibres pass upwards and medially behind the medial limb of the external abdominal ring, to insert into the linea alba. These fibres are known as the reflected inguinal ligament. Fig. 16.

Innervation

The muscle has a segmental innervation from the anterior divisions of the lower dorsal nerves.

The External Abdominal Ring

This is located above and lateral to the pubic crest, and is/

is an opening in the aponeurosis of the external oblique muscle for the transmission of the spermatic cord in the male and the round ligament in the female. From base to apex, it measures on an average 2.5 cms., and its width at the base is 1.25 cms. The base is formed by the crest of the pubis and the margins by the opening in the aponeurosis. The margins are termed the crura, and are interconnected by a series of fine fibres. The inferior crus is the more powerful and supports a part of the spermatic cord, while attaching to the pubic tubercle. The superior crus attaches to the anterior aspect of the symphysis pubis. From the intercrural fibres comes the external spermatic fascia covering the outer aspect of the cord.

The External Ring in Women

The external ring is smaller in women then in men and is often reinforced by powerful cross fibres which give added strength to the structure. It also lies more medially than in males, and, according to Donati 23, the external oblique aponeurosis is more powerful in women. The lower pillar of the ring is more horizontal than in the male and gives rise to intercolumnar fibres of considerable strength.

These factors have been considered to influence the sex incidence of direct inguinal hernia, as they combine to make an area, which in the male is comparatively weak, in the female very strong.

INTERNAL OBLIQUE

This lies between the external oblique and the transversus abdominis.

Origin

The muscle arises from the lateral half of the upper surface of the inguinal ligament, from the anterior two thirds of the middle lip of the iliac crest, and from the lumbodorsal fascia.

Insertion

The posterior fibres ascend to continue with those of the lower intercostals and the lower borders of the lower three ribs.

Those fibres rising from the inguinal ligament arch medially and downwards over the spermatic cord or round ligament, to become tendinous and insert with a portion of the transversus abdominis into the crest of the pubis, medial portion of the pecten pubis and lower lateral aspect of the rectus sheath. The remaining fibres form an aponeurosis which runs with an upwards/

upwards and medial direction to split into two layers encheathing the rectus abdominis and reuniting in the midline at the linea alba. Anteriorly, the aponeurosis of the external oblique is intimately blended with that of the internal, and posteriorly the posterior lamella of the internal fuses with the aponeurosis of the transversus abdominis and attaches superiorly also to the cartilages of the seventh, eighth and ninth ribs.

Innervation

The muscle is supplied by the anterior divisions of the lower dorsal and first spinal nerves.

The Internal oblique in Women

Donati [23] also believes that the pillars of the muscular internal ring are more powerful in the female than in the male and partly explains the lower incidence of indirect hernia in women.

TRANSVERSUS ABDOMINIS

The disposition of the fibres of this muscle is indicated by its name. It is the third of the three flat muscles of the abdominal wall and lies deep to the internal oblique.

Origin

From the lateral third of the inguinal ligament, the anterior two thirds of the medial lip of the iliac crest, the medial aspects of the cartilages of the lower six ribs, interdigitating with the diaphragm, and from the lumbo-dorsal fascia.

Insertion

The muscle fibres sweep medially into an aponeurosis with a transverse direction save in the lower part where the fibres direct downwards and medially to insert with fibres of the internal oblique into the crest of the os pubis and the pecten pubis, forming the conjoined tendon. The remaining fibres of the aponeurosis joins that of the internal oblique as part of the posterior layer of the rectus sheath and thence into the linea alba. In the lower fourth the aponeurosis lies anterior to the rectus which is deficient posteriorly in the lower third of its sheath.

Innervation

Nerve supply is by way of the anterior divisions of the lower dorsal and first lumbar nerves.

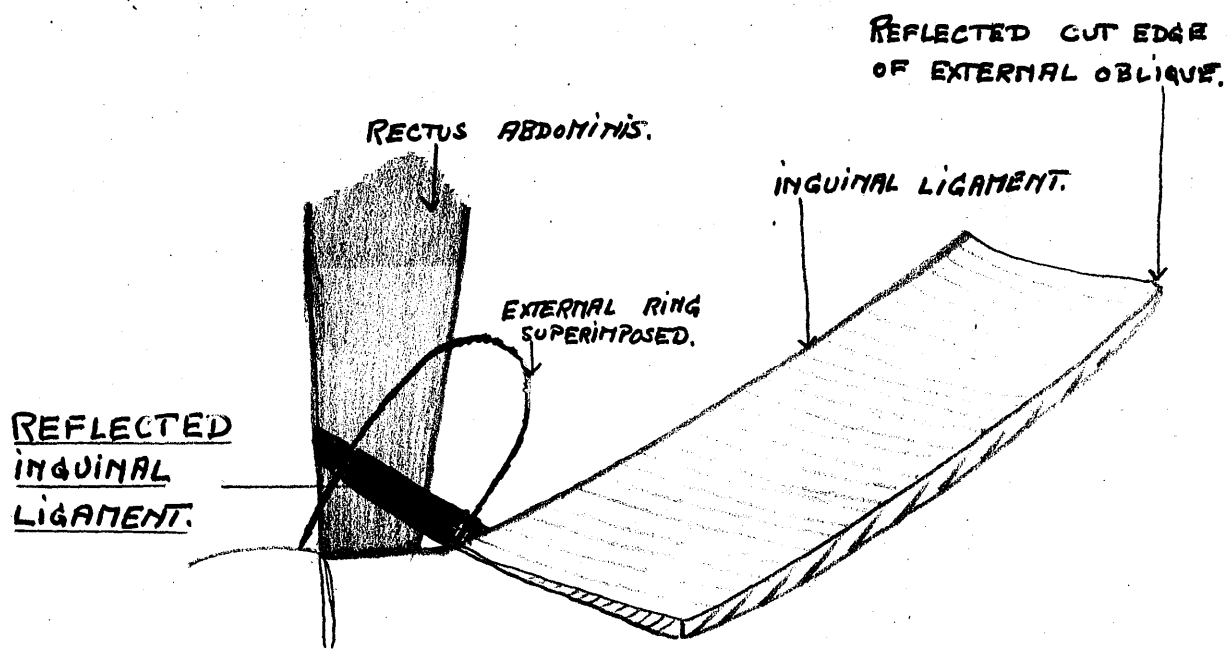


Fig. 16

THE REFLECTED INGUINAL LIGAMENT

THE RECTUS ABDOMINIS

This is a long, flat, strap-shaped muscle broader above than below, and extending from the xiphi sternum to the symphisis pubis. It is enclosed within a stout aponeurotic sheath which fuses laterally with the aponeuroses of the flat antero-lateral abdominal muscles, and medially with the linea alba. The muscle is intersected by three powerful fibrous bands extending throughout its substance from the anterior layer of the sheath to the posterior, and at right angles to it. They may be incomplete posteriorly but in effect divide the muscle into four subsections, thereby increasing its total power.

Origin

It arises by two tendons, a larger lateral attached to the crest of the pubis, and a smaller medial which interlaces with its fellow of the opposite side, and, attaching to the ligamentous fibres covers the anterior aspect of the pubis.

Insertion

The muscle is inserted by three slips into the cartilages of the fifth, sixth and seventh ribs.

THE RECTUS SHEATH

At the lateral margin of the rectus, the internal oblique aponeurosis divides into two lamellae which embrace the muscle, and reunite medially into the linea alba. The aponeurosis of the external oblique passes to the anterior layer of the sheath, and to the linea alba, whilst posteriorly that of the transversus abdominis/

abdominis, in the upper three fourths passes posteriorly to the rectus uniting with the linea alba, but in the lower fourth passes anterior, fusing with the anterior layer of the sheath.

Thus the rectus sheath posteriorly shows a deficiency in its lower fourth, and at the junction between middle and lower fourths the sheath ends in a curved margin, the linea semicircularis, the concavity of which is directed downwards. A point of considerable importance to the treatment of hernia is the relationship of the conjoined tendon to the lower part of the rectus sheath.

The observation was made by Polya [10, 11.] that in many cases, the lowest portion of the internal oblique may be deficient, or very weak, and that the so called conjoined tendon has then its insertion into the lower lateral aspect of the rectus sheath at a varying distance above the pubis. Bloodgood [12] made a similar observation and the question is also discussed by Foldes [13] and Skillern [14]. Foldes noted that the lateral aspect of the rectus sheath for a distance of two or three centimetres above the pubis may form the medial boundary of the inguinal canal, and that the conjoined tendon in such cases inserts to the rectus sheath above that level. Figs. 17-18.

Foldes described an area termed the inguinal triangle, which is really the posterior wall of the inguinal canal, and which/

which is normally formed by the inguinal ligament below, the muscular portion of the internal oblique above and laterally, and the conjoined tendon above and medially. Where the conjoined tendon has an abnormal insertion, the medial margin of the traingle is formed by the lowest two or three centimetres of the lateral margin of the rectus sheath, and the triangle is altered to a quadrilateral.

In a series of one hundred consecutive operations by myself, upon the inguinal canal for primary indirect inguinal hernia, the nature of the insertion of the conjoined tendon was noted. In forty-six cases, the structure could be observed attaching to the pubis and forming a stout posterior wall to the medial part of the canal. In twenty, the tendon inserted to the rectus sheath at least one inch above its lower extremity, and in the remaining thirty-four, the tendon had no attachment to the pecten pubis, but was inserted to the rectus in its last inch. In fifteen of these, there was poor connection by atrophic fibres, to the pubic crest. Therefore, in only 46% of cases in that series, were the correct anatomical findings as described by Gray [1]. found to be present. In 20%, the insertion of the conjoined tendon was abnormal, and in the remaining 34% abnormality to a greater or lesser degree existed.

It may be argued that in the cases examined, abnormal anatomy/

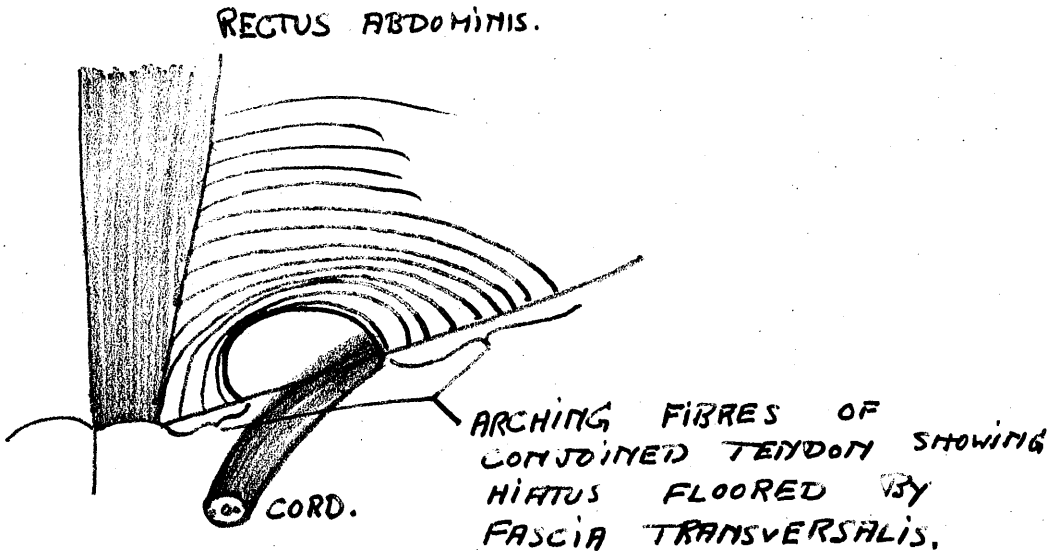


Fig. 17
NORMAL INSERTION OF CONJOINED TENDON

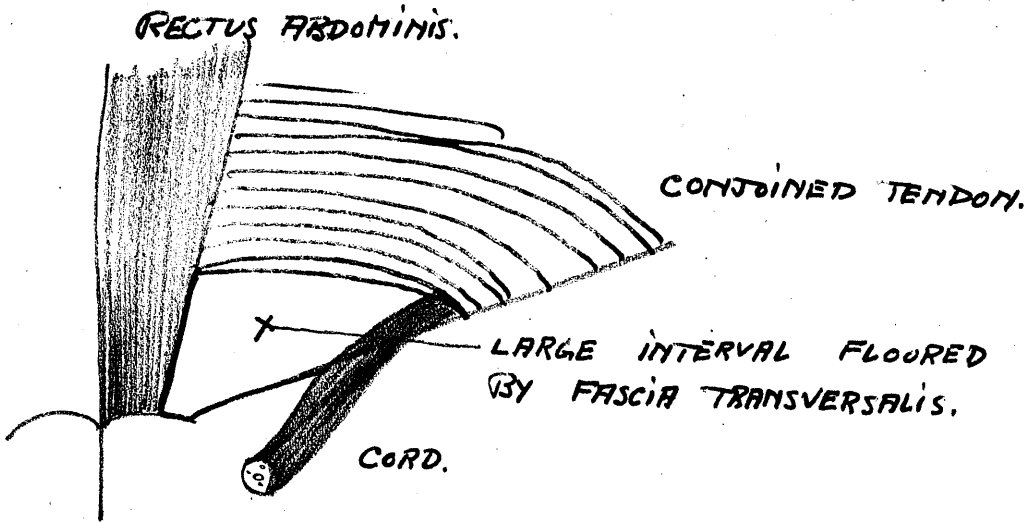


Fig. 18
ABNORMAL INSERTION OF CONJOINED TENDON

anatomy was bound to be present owing to the presence of a hernial sac, and that this in effect produced the abnormality. As against that argument it may be stated that those cases which showed the abnormal insertion of the conjoined tendon were in eight instances associated with small sacs and that the operation performed was simple herniotomy in virtue of the powerful canal, and the fact that the herniae were considered to be congenital in origin and not acquired. Six of the remaining twelve were found associated with large herniae, where it was not possible to distinguish cause from effect, and the remaining six were classified as moderate in size. There, a repair was performed, but it was considered that the presence of the hernia had not effected atrophy of the conjoined tendon, and that probably the abnormality described owed nothing of its origin to the hernia.

In eight operations for femoral hernia by the inguinal route, five were found to show some abnormality of insertion of the conjoined tendon, and in two, the abnormality was gross in degree. It is, of course, a common observation that in the direct type of hernia the conjoined tendon is deficient or atrophied but I would suggest that those surgeons who have written "deficient" really mean that it inserts to the rectus sheath rather than to the pecten pubis and pubic crest.

CREMASTER MUSCLE

This is described by Gray as being a thin muscle layer composed of a number of fasciculi which arise from the middle of the inguinal ligament where its fibres are continuous with those of the internal oblique and also occasionally with the transversus. It passes along the lateral side of the spermatic cord, and descends with it through the external ring upon the anterior and lateral surfaces of the cord, where it forms a series of loops which differ in thickness and in length. These loops are united together by areolar tissue, and form a thin covering over the cord and testis, the cremaster fascia. The fibres ascend along the posterior surface of the cord to insert by a small pointed tendon into the tubercle and crest of the os pubis, and into the front of the sheath of the rectus abdominis.

This description implies that the muscle is a thin and delicate structure, whereas the fact is that it is substantial in its dimensions. It is intimately adherent to the fascia transversalis and to the inguinal ligament. [15].

Anyone who has operated frequently upon the inguinal canal, must be well aware that the cremaster is a structure which, though atrophied in large and old standing herniae, is normally thick and extensive. It is not possible to dissect it/

it from the external and internal layers of spermatic fascia, with which it is intimately blended, saving in the dissecting rooms and by adopting special technique. Thus, on the operating table the three layers of fascia present as a fibro-muscular sheet enclosing the cord, but, of the three elements in this sheet the middle cremaster layer is the most powerful. It is the only one with muscle tissue as a conspicuous element, and is obvious on examination. In the distal extremity of the cord, the muscle is more thin and pale, but in the canal and over the pecten pubis better developed. The firm adhesion to the floor of the canal is of practical importance as it buttresses the area. When it has been incised, the elements of the cord can be readily dissected from within the sheath. There is a free potential channel of communication along the cord within the cremaster, through the internal ring, with which it blends, to the extraperitoneal tissues of the abdomen, and it is through this channel that the sac of an indirect hernia presents covered by internal spermatic fascia. It follows that in the operation for hernial repair, when the sac is removed it must be dissected out deep to the cremaster, and up to a level higher than that of the internal ring before the ligated stump can be freed out of the danger zone of recurrence. In order to close the internal ring, or narrow same, it is necessary not only to suture the pillars of the ring itself, but to include in the sutures the cremaster muscle and related fascia transversalis.

The deep epigastric vessels closely relate to the internal ring, and are deep to the cremaster muscle.

FASCIA TRANSVERSALIS

This is a membrane lining the abdominal wall on its inner aspect, and situated between the inner surface of the transversus abdominis muscle and the extraperitoneal fat. It is a part of the general layer of fascia lining the abdominal wall and continuous with the iliac and pelvic fasciae. It is a posterior relation of the inguinal canal, and there is more dense than in the upper abdomen where it blends with the diaphragm..

The increase in density in relation to the inguinal region is due partly to reinforcements of fibres received by it from the aponeurosis of the transversus, and partly as a result of the function which it fulfils in that region, namely support to the floor of the inguinal triangle.

This important fact was appreciated by the surgeon anatomists, Cooper and Scarpa [16] who made beautiful dissections of herniae, and demonstrated clearly that one of the more important factors in their development was rupture or deficiency of this fascial layer.

Lee MacGregor [17] states that it is merely a condensation of the extraperitoneal fat, but even so, it remains as a separate anatomical structure and of practical surgical importance.

A prolongation of the fascia transversalis over the vas gives the internal spermatic fascia, deepest of the three coverings of the spermatic cord.

OTHER FASCIAL LAYERS

There are other fascial layers, the internal and external spermatic which have already been indicated, and also the superficial fasciae of the lower anterior abdominal wall, those of Camper and Scarpa.

Fascia of Camper This is that portion of the subcutaneous fat in relation to a variable part of the lower abdominal wall, which is bounded on its deep surface by a well marked membranous condensation. It is continuous above and below with the general subcutaneous fat but over the scrotum is replaced by unstriped muscle called the dartos tunic. This muscle layer is involuntary, pale red in colour, and intimately attached to the scrotal skin.

Fascia of Scarpa This is the membranous deep condensation of the Camper layer, and seen as a glistening membrane capable of being confused at operation with the external oblique aponeurosis, at any rate to the eye of the novice. It is separated from the external oblique aponeurosis by a layer of areolar tissue. In suturing incisions of the lower abdominal wall, this layer should be repaired by a running stitch of fine/

fine cat gut, as it is an important element in the deep repair of the skin incision and encourages development of a scar which will not stretch. Between these two fascial layers are found the superficial circumflex iliac, superficial external pudendal, the superficial inferior epigastric vessels, with also the lymphatic glands of the groin.

THE DEEP EPIGASTRIC VESSELS

The artery arises from the external iliac immediately above the inguinal ligament. It curves forwards in the extraperitoneal tissue to ascend obliquely along the medial margin of the internal abdominal ring, pierce the fascia transversalis, and pass in front of the linea semicircularis to ascend between the posterior layer of the rectus sheath and the rectus abdominis muscle. It ends by anastomosing above the umbilicus with the superior epigastric branch of the internal mammary and with the lower intercostal arteries.

The venous return is to the external iliac vein.

The two vessels, artery and vein, can be readily identified at operation in relation to the neck of the hernial sac and medial margin of the abdominal ring. They are of importance in several respects. The direct type of hernia protrudes medial to the vessels, and the indirect type is found lateral to them. In the saddle bag or "pantaloon" type of hernia/

hernia, that is direct and indirect together on the same side, the deep epigastric vessels form a bridge between, which, were they not present would form one large hernia with a huge bell-tent-shaped sac. Finally, they act as a secondary factor in maintaining the strength of the posterior wall of the inguinal canal at the lateral end. [18] Elliot, who discusses this point, considers that division of these vessels during herniotomy, favours recurrence.

ILIO-HYPOGASTRIC NERVE

This is classically described as arising from the first lumbar nerve, emerging from the upper part of the lateral border of the psoas major, crossing behind the kidney to reach the iliac crest, and then perforating the posterior part of the transversus abdominis to divide superficial to that muscle, and deep to the internal oblique, into a lateral and an anterior branch. The lateral pierces the internal and external oblique muscles, immediately above the iliac branch of the 12th dorsal nerve, and distributes to the skin of the anterior part of the side of the buttock. The anterior runs between the internal oblique aponeurosis, and that of the external, downwards and medially to a point about one inch above the external abdominal ring where it perforates the external oblique aponeurosis, to distribute to the skin of the abdominal wall above the os pubis.

It also has communications with the 12th dorsal and ilio-inguinal nerves.

This nerve may or not be of importance to the subject of inguinal hernia, and the classical description of the anatomists, quoted from Gray's textbook, does not tell the whole story. The significant points are; what parts exactly of the flat muscles of the abdominal wall are supplied by the nerve, and where do the twigs of supply leave the main trunk in relation to the area exposed during operation upon the inguinal canal? There is also the question as to whether or not these motor twigs are capable of being damaged by a gridiron incision for appendicectomy, and if so, whether the resultant inhibition of a part of the internal oblique or transversus, may be a factor in the development of later inguinal hernia.

The question first, therefore, is whether that part of the nerve ordinarily exposed during hernial operations in the inguinal region, is sensory, motor, or mixed.

The experimental evidence for a solution to these points is submitted in a later Chapter. It may be stated briefly, that evidence adduced by Moschowitz and Neuhof [19.] suggests that the area exposed during hernial operations is purely sensory, but that the posterior part is mixed. [20.] Division of the ilio-hypogastric nerve at operation gives an area of skin anaesthesia round the lower angle of the incision and extending/

extending from about 7 cms. above the pubis to 1 cm. from it.[21.] There is a possibility that in the McBurney gridiron incision, the motor segments may be destroyed. The motor fibres supply the lower part of the internal oblique and transversus muscles, and probable also the conjoined tendon.[22.]

The integrity of these motor fibres is essential for maintenance of tonus in the conjoined tendon, and therefore also to the security of the posterior wall of the inguinal canal.

Two other points concerning the anatomy of this nerve are of consequence.

The nerve is generally intimately adherent to the overlying aponeurosis of the external oblique, in the region of the inguinal canal, and in opening up the canal it is important whilst making the incision in the aponeurosis not to cut it, and also when suturing the structure not to include the nerve in a stitch. This last mishap may be followed by intractable referred neuralgic pain to the area over the pubis.

Secondly, the nerve may relate rather to the lower edge of the conjoined tendon in the canal itself, and perforate the external oblique more medially than normal. This suggests that during herniorrhaphy, sutures inserted to adjust the position of the conjoined tendon, may enclose the nerve, again with risk of referred neuralgic pain. Thus it should be exposed at all operations, and care taken not to traumatise it.

ILIO-INGUINAL NERVE

This nerve arises from the first lumbar, passes below the ilio-hypogastric, but enjoys similar relations so far as the anterior part of the iliac crest where it perforates the transversus and communicates with the ilio-hypogastric. It then pierces the internal oblique muscle, gives motor filaments to it, and, accompanying the spermatic cord through the external ring distributes to the skin of the upper and medial area of thigh, skin over root of penis and upper part of scrotum in the male and mons veneris and major labia in the female.

Division of the ilio-inguinal and genito-femoral nerves at operation results in loss of sensation in cord, hernial sac and testicle, and a skin area of anaesthesia on the inner side of Scarpa's triangle. [21.]

EXTERNAL SPERMATIC NERVE

This is the only other nerve requiring mention, and that because it is motor to the cremaster. It is a branch of the genito-femoral, itself coming from the first and second lumbar nerves, and passes through the inguinal canal with the cord, entering the canal at the internal ring. It also gives some cutaneous fibres to the skin of the scrotum.

OBLITERATED HYPOGASTRIC ARTERY

This landmark courses over the floor of Hesselbach's traingle, that is the traingle bounded medially by the outer border of the rectus, laterally by the deep epigastric artery, and below by Poupart's ligament.

The only significance it has in relation to herniae is as a boundary serving to subdivide direct funicular sacs into those emerging above the vessel - external direct hernia, and those emerging below and medial to it - internal direct herniae. The subdivision is of little practical importance.

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CHAPTER 7

FUNCTION OF THE INGUINAL CANAL AND ASSOCIATED STRUCTURES

The function of the inguinal canal is primarily to form a channel through which the vas deferens and vessels of the testis may be transmitted from the abdomen. It is formed in consequence of the peculiar method of testicular development, and as a result of this naturally forms a potentially weak area in the lower abdomen through which peritoneum and viscera may be extruded when, for one reason or another, muscle tonus has been lost.

The internal and external abdominal rings are placed so as to form a valve which minimises the effect of the presence of the canal, and the disposition of the muscle fibres is such that in the erect posture the muscles are approximated to one another, shutting the potential space still more firmly off. It is a common experience to find a canal where the muscles are deficient in tone, where they have been stretched by a hernial protrusion, and where the rings are dilated to a degree that the entire structure loses its competence. The method whereby the integrity of the canal is maintained must be investigated, if the factors which lend to formation of a hernia are to be understood, and the problems of cure surmounted.

THE FUNCTION OF THE FLAT ABDOMINAL MUSCLES

The internal and external oblique muscles compress and support the abdominal viscera and assist in the acts of defaecation and micturition. They assist in the acts of vomiting and aid the expulsion of the foetus from the uterus. These movements are possible with the thorax and pelvis fixed, but where the pelvis and vertebral colums are fixed the muscles depress and compress the lower part of the thorax and are accessory to forced expiration.

When the pelvis alone is fixed, these two muscles effect forward flexion of the trunk when acting on both sides, unilateral action producing flexion to the active side.

The action of the transversus abdominis is to compress the abdominal contents. [1].

Finally, the rectus abdominis, acting from above, elevates the front of the pelvis, but from below depresses the thorax and is capable of flexing the vertebral column. The two recti compress the abdominal viscera.

Were these muscular sheets intact, their effect would be one hundred per cent efficient in retaining the abdominal viscera in situ, but the presence of the inguinal canal weakens the lower part of the anterior abdominal wall. This weakness is partly compensated by the obliquity of the canal and the fact that the two rings do not lie directly opposite one/

one another. Thus, increases in intra-abdominal tension exercise their effects not only at the internal ring, but also on the posterior wall of the canal approximating it to the anterior, and tend to close the potential space which exists, so reducing liability to hernial formation.

The factors of importance in the function of the canal are those which help to maintain its integrity.

1. The action of the internal abdominal muscle ring as a sphincter.
2. The poss ible sphincteric action of the conjoined tendon.
3. The motor supply of the internal oblique and transversus abdominis from the ilio-hypogastric nerve, and the effect of injury to this nerve upon these muscles.
4. The action of the conjoined tendon during movements of the lower limbs.
5. The relation of the function of respiration to that of the inguinal canal.
6. The effects of straining due to any cause, upon the inguinal canal.
7. The response of the canal to the presence of a performed hernial sac.

THE INTERNAL ABDOMINAL RING AS A SPHINCTER

The spermatic cord at the internal ring is surrounded by muscle which may justifiably be called the "inguinal sphincter". [2.] The muscle is voluntary, possessed of a distinct and separate motor supply, and in health constantly in a state of tonus, while during periods of increased intra-abdominal tension, this tonus is voluntarily increased and the ring/

ring contracts. If the sphincter becomes relaxed or atrophied, the internal ring dilates to permit the entry of a wedge of peritoneum as a result of variation in intra-abdominal pressure. An old and recognised method of avoiding military service and practised especially in Eastern Europe, has been to dilate the external ring and canal by frequent invagination of the scrotum by a finger, thereby stretching the muscles and sphincter reducing the effectiveness of the inguinal mechanism, and in consequence, producing a hernia. This is a practical application of the relationship of inguinal hernia to the abdominal musculature. The methods whereby this protrusion of peritoneum can be produced with a relaxed inguinal sphincter are:

1. By prolonged abdominal straining due to cough, or constipation.
2. Physical exertion in a stooping position.
3. A sudden increase in intra-abdominal tension for any reason which occurs so unexpectedly that the sphincter is "taken off its guard" and voluntary contraction has not time to develop.
4. Atrophy due to nerve section as after a McBurney gridiron incision.

MacGregor [2.] has written that proof of the existence of this sphincter lies along anatomical, empirical and experimental lines.

He states that in the dissecting room when the external oblique aponeurosis has been incised and retracted, the cord can/

can be dissected up to the internal ring, when it can be clearly demonstrated that "the so called arching fibres at the attachment of the conjoined tendon round the ring, not only arch over the cord, but actually course completely round it, interposing themselves below between the cord and the inguinal ligament." In this manner, the contained muscle fibres form a complete and grossly definable sphincter for the canal at the internal ring.

A similar observation has been made by Hammond [3.] who wrote that the arching fibres of the internal oblique and transversus above the cord when contracting become opposed to Poupart's ligament and act as a sphincter to close the internal ring, pressure on the spermatic vessels being prevented by the downward convexity of Poupart's ligament.

Finally, Cawell, quoted by MacGregor [4.] has described a vascular ring surrounding the internal ring, and remarked upon the similarity of its architecture to that of vessels ordinarily supplying sphincteric mechanisms.

It is a noteworthy omission in the anatomical textbooks that this sphincter is not adequately described. Both in the dissecting room, and in the operating theatre, I have personally found the same arrangement of fibres as described by MacGregor, and anyone who has adequately dealt with an inguinal hernia and dissected the sac up to the internal ring must/

must have observed that the cremaster fibres blend with the ring and that the interlacing of fibres from the internal oblique and transversus with those of the cremaster extends right around the cord and attaches posteriorly to the transversalis fascia and inguinal ligament. Whether or not the ring of muscle has a sphincteric action, however, is another question, but the anatomical evidence is strongly suggestive. MacGregor conducted certain experiments to clear up this point, and the results of the experiments were conclusive.

MacGregor exposed the internal ring in a dog and applied to it minimal stimuli with the electrodes of an induction coil. He thereby produced well-defined circular contractions of the cord involving the entire sphincter in equal degree. This contraction was sufficient markedly to reduce haemorrhage from a cut in the spermatic artery. This, he observed to be a true rule of sphincters in general, that they either contract entirely or not at all.

He next exposed in the dog, a small branch of the inguinal division of the ilio-inguinal nerve running towards the internal ring. Stimulation of this branch invariably produced circular contraction of the internal sphincter identical with that of direct stimulation of the structure. Finally, this nerve was sectioned, and at the end of a week the wound re-opened. The sphincter was found to be relaxed to such a degree/

degree that there was an opening one inch in diameter, whereas the surrounding muscles were uninvolved. The sphincter was then removed by careful dissection and subjected to microscopic examination. The muscle was found to be skeletal in type, implying that the sphincter is voluntary in character. In the animal whose nerve had been cut, the skeletal tissue showed degeneration typical of that following a motor nerve rhexis.

The evidence suggests the presence of a sphincter at the internal ring, and it is of consequence to determine its innervation.

Moschcowitz and Neuhof [5] exposed the ilio-hypogastric nerve in a series of cases, and stimulated it with a mild faradic current. In some cases, there was a muscle contraction of the internal oblique, and in others, there was none.

In a second series the nerve was exposed and divided. The severed ends were then stimulated with faradism of varying intensity, and again with doubtful results. Finally, it was decided that the current was being conducted by moisture along the nerve, and it was found that similar contractions could be provoked by sending faradism into the muscle on a piece of wet silk thread, but not on dry silk thread.

They then followed up the cases where the nerve had been sectioned and found the end results good. They therefore concluded that the ilio-hypogastric nerve as exposed during hernia operations is purely sensory.

A series of experiments were then conducted in dogs in which they sectioned the anterior nerve roots at their point of emergence from the anterior horns of eleventh and twelfth (dorsal segments. 78) days later they studied degenerations of the nerves in a serial sections and decided that the posterior part of the nerve is mixed and that motor fibres are absent from the anterior part.

Andrews [6]. conducted an investigation along somewhat similar lines and with similar conclusions.

These workers have established that the motor supply to the lower fibres of the internal oblique and transversus abdominis are given off above the internal ring, and that the nerve as exposed in the canal is purely sensory.

The anterior branch of the nerve is located one inch medial to the anterior superior spone where it perforates the internal oblique to lie deep to the aponeurosis of the external. This is the branch carrying motor fibres, and it is prone to harm during the fashioning of a gridiron incision. At this point fibres are given off to the lower part of the internal oblique, and at a distance of little over one inch from/

from the upper margin of the internal sphincter. The evidence suggests that the innervation of the sphincter is via these fibres. It is a common observation that inguinal hernia may follow within a year of appendicectomy.[7.] This may be considered to be due entirely to the frequency with which the two conditions afflict Mankind and to be only a coincidence. The evidence suggests there may be an association between the two events.

The relationship between the conjoined tendon and the ilio-hypogastric nerve is similar to that between the nerve and the internal ring. It derives its motor power through the ilio-hypogastric nerve and atrophies as a result of trauma to it. This reduces the strength of the posterior wall of the canal.

FUNCTION OF THE CONJOINED TENDON

The conjoined tendon gives powerful support to the medial part of the posterior wall of the inguinal canal[8.] but, in addition it subserves yet another function.

I performed a series of herniotomies under local anaesthesia and observed that with the conjoined tendon relaxed, there was a distinct interval between its lower border and Poupart's ligament. This interval was overlaid by fascia transversalis. When the tendon was rendered taut by the patient's efforts at coughing, attempting to elevate shoulders and/

and head from the table, or by straining, the interval between the two structures was reduced. This shutter like arrangement according to Keith [2]. is an important factor in the prevention of direct herniae. He states that when a strain is imposed upon the two muscles forming the conjoined tendon, they contract reflexly, thus increasing the area of the posterior wall of the canal to which they afford protection and preventing the extrusion of gut. Keith also states that he does not believe in Man that the interval between the tendon and the ligament can ever by completely obliterated by contraction of the tendon, and assigns the cause of this to the fascia transversalis. Figs. 19 and 20.

He suggests that in the living infant the normal attitude is one of thigh flexion, abduction and external rotation. In this position the tendon and fascia transversalis are relaxed and their effect as a guard to the canal and rings minimal. When the upright posture is assumed and the thighs extended, the two structures are rendered taut. In Man, the fascia transversalis has assumed a part of the function of the tendon and developmentally, the tendon is less important than in mammals.

The type of movement which may occur suddenly and cause a strain to be imposed upon the posterior wall of the canal whilst the fascia transversalis and conjoined tendon are relaxed/

relaxed and the posterior wall unprotected, is when, with the feet firmly braced, the thigh suddenly flexes. The tight fascia and tendon are suddenly relaxed. If the strain continues a process of peritoneum may be extruded through either the internal ring, or a tear in the fascia transversalis develop which initiates a direct type. [10.] This sequence of events occurs rapidly and the sac is extruded before the tendon and fascia have time to protect the area which has suddenly been left vulnerable. This is the sequence of events meant by the phrase "taking the sphincter off of its guard." The conjoined tendon has a sphincteric action comparable, according to Andrews, to that of the sphincter ani externis.[16.17.]

The fact that the conjoined tendon, fascia transversalis, and flat abdominal muscles are relaxed when the thighs are flexed is of practical importance in two respects.

First of all, during operation, when it is desirable to have maximal muscle relaxation to effect repair, this may be assisted by adjusting the table to flex the thighs slightly on the trunk.

Secondly, it is advisable to maintain this attitude of physiological relexation, or "Jack Knife Position" during the period of convalescence in order to reduce liability of sutures tearing out, or of stretching of young scar tissue. For the first two weeks, the position should be maintained in bed/

bed, and this point has been frequently stressed by Lyle and other workers. [11, 12, 13, 14, 15.]

RELATION OF FUNCTION OF RESPIRATION TO THAT OF THE INGUINAL CANAL

Morphologically, the antero-lateral flat abdominal muscles are continuous with those of the thorax, and have a relationship to respiration.

Keith established that the great characteristic common to all mammalia was the development of a diaphragm completely separating the thorax from the abdomen. With its development came an associated increase in respiratory power.

In early vertebrate life, abdominal muscles as well as diaphragm were primarily concerned with the circulation, [18.] but with the development of ribs and lungs, the abdominal wall as well as diaphragm became respiratory in function. The central tendon of the diaphragm is closely bound to the pericardium, and in all mammals this is attached to the lung roots. On inspiration, the central tendon, heart and pericardium, and lungs, move downwards and forwards. This movement of the lung root, according to Keith, quoted by MacKenzie [18.] is essential for apical lung expansion. The diaphragm acts primarily by increasing the capacity of the chest and compresses the abdominal organs like a piston. This is possible only/

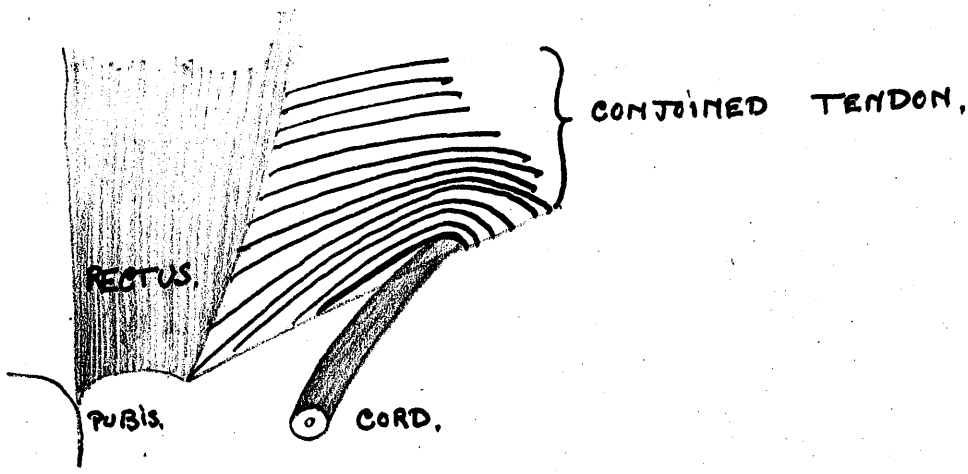

Fig. 19

CONTRACTION OF NORMAL CONJOINED TENDON

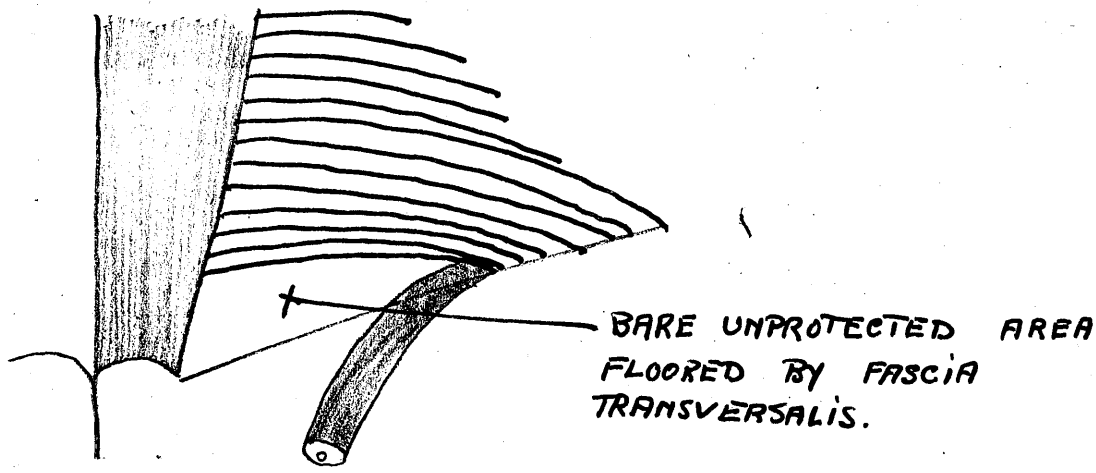

Fig. 20

CONTRACTION OF ABNORMAL CONJOINED TENDON

only by reciprocal relaxation and elongation of the abdominal diaphragm primarily and not to the erector spinae. That the abdominal muscles are capable of flexing the trunk has been previously indicated, but the relationship to the diaphragm is of importance.

Weakness of the abdominal muscles means less resistance to the descent of the diaphragm, which by its contractions for ces the viscera downwards. Owing to the curved plane of the abdominal wall, whilst the perpendicular pressure is constant under such circumstances the tangential pressure varies. The main effects are referred to any potentially weakened areas, and of these, the inguinal canals have high priority.

Under such circumstances, Keith says hernia is liable to develop. The main factor he argues, is not continued degrees of high intra-abdominal pressure, but minor often repeated impulses. [19].

Sudden increases in intra thoracic pressure such as sneezing or coughing produce increase in the pressure, within the inguinal canal by forcible contraction of the abdominal muscles and where these are incompetent, or the inguinal sphincters relaxed or atrophied, possibilities exist for development of a hernial sac.

In health, the abdominal musculature is adequate to deal with/

with all such calls made upon it, and the valve like arrangement of the canal is a mechanism efficient enough to guard against the protrusion of a peritoneal sac. In health the descent of the diaphragm on inspiration produces a pressure which is at first directed downwards, and then downwards and outwards, and closes the canal by contraction of the abdominal muscles, compression being always equal to, or greater than the pressure exerted on the internal ring, thus obviating any tendency for the organs to protrude.

EFFECT OF SUDDEN STRAINS OF INGUINAL CANAL

The inguinal sphincter is part of the abdominal muscles, and its contraction synchronous with theirs. As the rise of pressure is secondary to the action of the abdominal muscles, the internal ring is protected by the action of the sphincter before any strain is thrown upon it. The development of the sphincter is proportionate to that of the abdominal muscles, and any rise of pressure is dependant upon the force of their contraction. Any muscular effort which endangers the canal will be resisted by an effort in proportion to that expended.

It is possible, in severe or prolonged strains to overcome the sphincter and expose the ring to pressure. Often minor traumata rather than sudden severe strain are the most important.

The carrying out of a great range of movement or of intricate movements, is made possible by perfect muscle co-ordination, but inco-ordination may develop suddenly through a slip or unsuspected movement, and if a patent sac is present, the internal ring and inguinal sphincter being caught off their guard, permit the entry of bowel into the sac.

Under similar circumstances, where the conjoined tendon is relaxed suddenly and the inferior part of the posterior wall no longer protected, whilst at the same time a rise in abdominal pressure is maintained, then a small sac may protrude directly through and lead ultimately to direct hernia formation.

The inguinal canal and sphincters, will respond well to strain and to constant calls made upon them by compensatory muscle hypertrophy. The more work the muscles are called upon to do, the more power they are likely to develop, and so long as the sphincter mechanism is not taken by surprise, the muscles prove adequate to demands made upon them. This is the basis of post operative exercises after herniotomy. The intention is to tone up the muscles to enable them to withstand the pressure to which they will be subjected when the patient leaves bed and assumes again an upright posture.

Herniae are as likely to develop in well built abdomens as in the weak. What are the reasons for this? In many cases/

cases of inguinal herniae the abdominal muscles are powerful and the canal not dilated. The condition may not have developed for several decades after birth, and clearly if there is a congenital patent sac there must be some explanation as to why hernia as such did not arise at a much earlier date. The protrusion of a viscus into the sac in these cases cannot be attributed to weakness of the abdominal muscles, and it is here where the muscles are powerful and the canal and rings not dilated, that repair by simple removal of the sac alone is adequate. The explanation must lie, not in the existance of the congenital sac as such, but in the factors which lead up to the upsetting of the inguinal mechanism and permitted the viscus to be extruded through relaxed rings. This is the type of strain which may be unnoticed at the time of its occurrence and be effective through "taking the sphincters off their guard."

MECHANISM WHICH TAKES "SPHINCTERS OFF OF THEIR GUARD."

When the thighs are flexed, abducted and externally rotated, the posterior wall of the canal is relaxed and the sphincteric action of the conjoined tendon minimal. At the same time, the fascia transversalis which buttresses the posterior/

posterior wall of the canal is slack. The interval between the inferior margin of the conjoined tendon and the inguinal ligament is then poorly protected. [20.] Extension, abduction, and medial rotation of the thigh by the actions of walking tighten the transversalis fascia and increase the effect of the conjoined tendon. Any movement which causes sudden flexion, abduction and external rotation of a thigh whilst an increase in intra abdominal pressure is being maintained, will predispose to the formation of a direct hernial sac. The sac being present, further repeated minor traumata or a second similar unexpected slip, may lead to the protrusion of a part of a viscus.

Any sudden movement causing relaxation of the abdominal muscles with consequent relaxation of the internal ring whilst an intra abdominal increase in pressure is maintained will predispose to formation of an indirect type of sac, or if a congenital sac be present, to development of an abvious hernia. This mechanism is seen when lifting a heavy load the muscles are taut, a foot slips and the weight is suddenly removed. The muscles then relax but the pressure within the abdomen may be maintained by descent of the diaphragm and deep inspiration, or sudden gasping. Many hernia are associated with such a history of strain, and only one may have been noted by the patient, the swelling being seen shortly afterwards. In such a case a congenital patent sac is probably present.

The presence of a patent sac per se is not dangerous so long as no unexpected pressure is imposed on the muscles, and so long as the muscles are efficient. In health and with normal degress of effort being called forth, hernia will not develop.

Severe strain with the feet firmly braced does not seem, according to Fallis [10], to initiate hernia, but when the foot slips and the thigh flexes, the buttressing effect of the external oblique is removed and the internal ring rendered more vulnerable by being practically and momentarily ungarded. Increased intra abdominal pressure being maintained under these conditions predisposes to indirect hernial formation.

THE RESPONSE OF THE CANAL TO A PREFORMED HERNIAL SAC

Under ordinary circumstances and in health, a preformed sac is not dangerous, and only as a result of these factors which have been reviewed above, and which result in muscle weakness, or in muscles being taken off of their guard as a result of sudden unexpected strains, is the sac of importance. Then it may be filled with part of a viscus, and hernia appear.

When this occurs, the swelling is at first reducible, but with its formation the inguinal mechanism has been rendered less perfect and the condition is liable to recur after a

less/

less powerful strain than was required for the first occasion. Each successive descent further weakens the structure of the canal so that it becomes progressively less competent and anatomical changes follow. The rings become permanently dilated to a greater or less degree, the muscles are weakened, muscle tonus is lost, and in due course, their effectiveness is negligible.

C O N C L U S I O N S

From an analysis of the anatomy and function of the inguinal canal it appears that the structure is an intricate structure which depends for its efficiency upon powerful and integrated action of the anterolateral muscles of the abdomen, the buttressing effect of the fascia transversalis, and the sphincteric actions of the conjoined tendon and internal abdominal muscular ring. In health this mechanism is valvular, and prevents development of hernia, but, as a result of strains multiple or single, minor or major, in the presence of a congenital patent sac, with the muscles in a state of relaxation, hernia may appear. The possibility of muscle weakness following upon gridiron incisions for appendicectomy through section of certain motor fibres from the ilio-hypogastric nerve to the lower part of the internal oblique is important. This may reduce the efficiency of the inguinal canal and predisposing to hernia formation.

As the presence of a patent congenital sac may predispose to the development of hernia, and especially when associated with strains, it follows that a rational repair for those cases of inguinal indirect hernia, where the muscles and abdominal rings are efficient, consists of removal of the sac alone and in relying upon the normal mechanism of the canal to prevent recurrence.

It is equally obvious that where the muscles are weakened, canals stretched and rings dilated, or where there has been motor nerve damage, that an effective repair, must strengthen both the internal abdominal ring in order to supplant the impaired sphincter, and also the posterior wall of the canal. Also the patent peritoneal sac must be removed at a high level.

The nature of the anatomy of the fascia transversalis and conjoined tendon demonstrate the need under such circumstances, for an operation, which will particularly reinforce the medial part of the posterior wall of the canal where the conjoined tendon may be poorly developed or insert, in an abnormal fashion. It is in this part, laterad to the pubis, that direct hernia is liable to develop, and any efficient plastic repair must guard this area as well as the internal ring.

From a study of the conjoined tendon one sees that the structure is often not suitable for use as an instrument in repair. Also, a deficiency exists below its inferior margin which/

which is protected primarily by the fascia transversalis, and the importance of this structure as an operative factor is evident.

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CHAPTER 8

STRUCTURE AND CLASSIFICATION OF INGUINAL HERNIAE, ANATOMY OF THE SAC.

Hesselbach [1] divided inguinal hernias into external and internal varieties, depending on their relation to the deep epigastric artery.

The external hernias are also known as "oblique" or "indirect"; the latter term, which describes the oblique position taken by the hernia in its passage from the internal to the external ring, is the one most commonly used.

The internal hernias which pass between the deep epigastric artery and the edge of the rectus muscle are known as direct, because they come directly through the abdominal wall, internal to the internal abdominal ring.

STRUCTURE OF INGUINAL HERNIA

A hernia consists of contents, a sac containing them, and the overlying coverings.

1. THE CONTENTS It has been stated that any abdominal viscus may be found within a hernial sac. Usually, however, it contains omentum or intestine, caecum or colon. The large intestine is less frequently present than the small, and omentum more than any other viscera.

(a) If a Meckel's diverticulum is present, the condition is known as a Littre's hernia. This is uncommon, and more frequent in femoral than in inguinal herniae.

(b) Where only a small part of the circumference of the bowel is involved, there is a Richter's hernia. This is found only in small sacs, where the neck is narrow, and is of significance in that strangulation may develop in the absence of any previous warning of its presence.

(c) Where the caecum, bladder, or ascending colon are located in a hernia, but outwith the sac, which is stretched over them.

The sac may contain small fibrinous bodies where the hernia is long standing, and frequently also small quantities of free fluid. Loose bodies are uncommon, but may be multiple, and vary in size from a pin's head to a split pea.

2. THE SAC The sac springs from that part of the peritoneum which originally overlay the internal ring, and is formed from normal peritoneum. It may be multilocular or hour glass shaped and vary in size from a tiny diverticulum seen with difficulty at the internal ring, to a huge voluminous beg filling the scrotum, stretching it and causing it to depend to the level of the knees.

As the hernia increases in size it enlarges, thickens, and alters in shape. The neck may remain narrow, but more frequently stretches, and accordingly stretches the related muscles of the internal ring and canal itself. It is adherent to a greater or less degree, to the surrounding tissues, and it must be remembered that when a hernia has been reduced, the/

the sac still remains in situ, ready once again to receive any viscus which may be extruded into it.

It may be congenital or acquired.

(A) Congenital

(1) Vaginal or Congenital Indirect Inguinal Here the processus vaginalis fails to obliterate at any point, and there is a free communication between the peritoneal cavity and the base of the scrotum. The vas and testicular vessels are embedded in the wall of the sac, a point of very practical importance to the surgical treatment.

(2) Funicular The processus is partly obliterated above the testis, but a process of peritoneum still extends into the inguinal canal.

(3) Interstitial Here there is a sac arising as a diverticulum from the original processus vaginalis, and located between the muscle layers of the abdominal wall.

(4) Infantile Here the processus is obliterated above the testis, but a diverticulum remains anterior to a funicular sac.

(5) Encysted This is a congenital sac, plus a second process of peritoneum lying front of the congenital sac up to the external ring.

1. Infantile or Encysted Hernia (Hernia with a double Sac).

Infantile and encysted hernia are similar. This type was first observed by Mery [2.] and Petit [3.] in 1701, by LeCat[4.] in 1753, and was described by Hey [5.] in 1764. Hey designated it Infantile Hernia, possibly because the case he saw was in an infant. Later, Cooper [6.] found it associated with a hydrocele and gave the name Encysted Hernia. The only difference between Hey's and Cooper's cases was that in Hey's the tunica into which the hernia protruded was empty, and in Cooper's the tunica vaginalis contained a hydrocele.

In infantile or encysted hernia the processus vaginalis is closed only at the internal ring. Intraabdominal pressure aided by the descent of the testis causes a sac or pouch of peritoneum to descend in front of the cord or vaginal process. More usually there is an invagination of the hernial sac into that of a hydrocele. These hernias have three layers of serous membrane between the sac contents and the skin, the peritoneal sac, and two layers of tunica vaginalis. These are interconnected at the neck of the sac.

Interparietal (Intraperietal, Intestitial) Hernia

Interparietal hernia is almost always indirect and usually occurs in the male, as a result of an anomaly of testicular development. Three varieties are described.

1. Properitoneal In properitoneal hernia the sac burrows between the peritoneum and the transversalis fascia. There are often two sacs which may be hour-glass shaped or bilocular.

All hernias with bilocular sacs communicate by a common opening with the abdomen.

2. Interstitial In interstitial hernia the sac burrows either (a) between the transversalis muscle and fascia; (b) between the fibres of the internal oblique muscle; (c) between the internal and external oblique muscles; or (d) between the transversalis fascia and the external oblique muscle or aponeurosis.

(B) Acquired

(1) Oblique
This is a process of peritoneum extending through the internal ring for a variable distance towards the base of the scrotum.

(2) Direct
The direct sac penetrates the fascia transversal is medial to the deep epigastric vessels, and is overlaid by the stretched or atrophied conjoined tendon. Two varieties are described:
(a) Diffuse
This is a generalised bulge of the posterior wall of the canal.

(b) Funicular
A sac penetrates the fascia transversalis at any point in the posterior wall, frequently just lateral to the pubic tubercle. It may be several inches long and with a narrow neck, and may be

(1) External — According to its relation to the obliterated hypogastric artery.

or (2) Internal.

(3) Saddle Bag or Pantaloon
Here there is a direct and an indirect sac both present on the same side, but separated from one another by the deep epigastric vessels. The two sacs overlie the vessels as do saddle bags on pack mules.

The typical oblique or funicular sac, whether congenital or acquired, has three anatomical divisions - neck, body, and fundus. The neck is that part in relation to the deep aspect of the internal ring. At this point it is frequently thickened and may be attached to the cord by adhesions. This attachment is of importance surgically, and must be freed at operation, otherwise the ligated stump will not retract to a sufficiently high level to prevent recurrence.

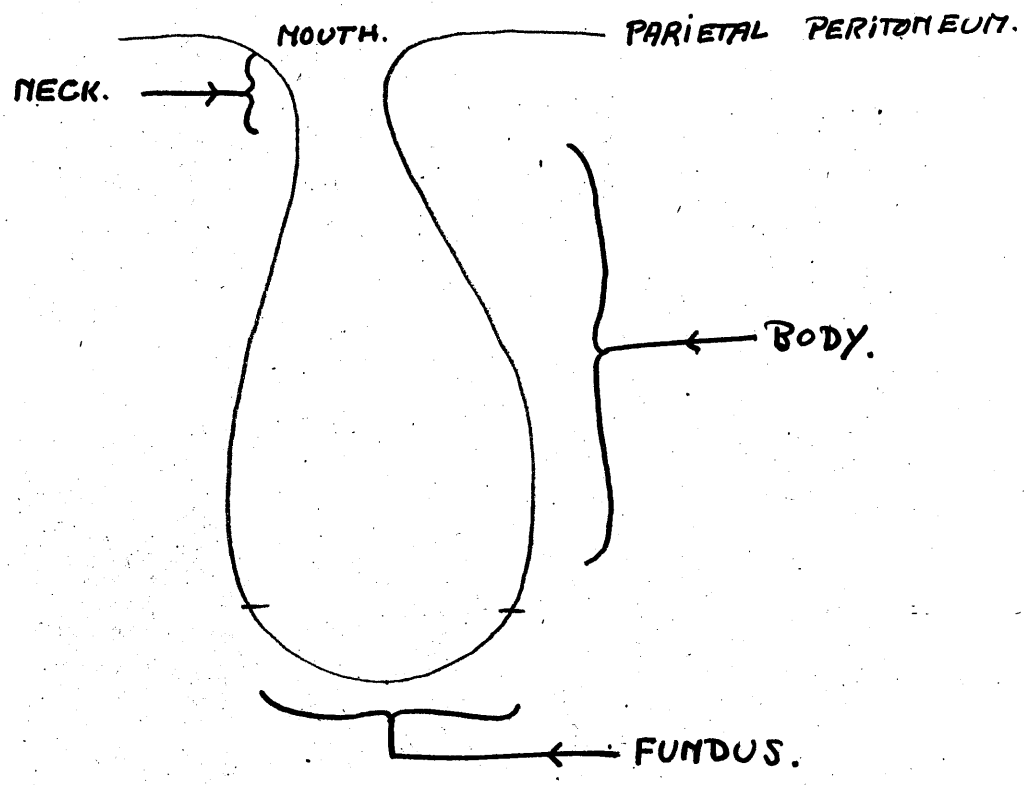

Fig. 21
DIAGRAMATIC ILLUSTRATION OF TYPICAL HERNIA SAC

The body varies in shape and in size, and may be adherent to its related tissues in the cord.

The fundus is rounded and may be located anywhere between the internal ring and the base of scrotum.

It must also be remembered that a hernial sac bears a close relationship to any undescended testicle in the canal, though under such circumstances, the problem usually centres round the testicle rather than the potential hernia.

The unobliterated processus vaginalis forming the sac of congenital herniae almost invariably lies anterior or superficial to the structures of the cord. Only in large and chronic cases does the cord lie along its inner side.

An acquired sac might reasonably be expected to develop along the site previously occupied in foetal life by the processus vaginalis, but the obliteration of this is usually so complete that in an acquired inguinal hernia it finds an easier pathway along the inner side of the deep epigastric vessels.

The text book description is usually, that the deep epigastric vessels and cord lie on the inner side of the neck of the sac in oblique herniae. This is so in large chronic cases, but in the small types where the sac is still in the canal, the neck is on the inner side of the cord and between it and the deep epigastric vessels.

With increase in size of the sac, there must take place some degree of rotation round the cord to account for this change in relationship. Elliot [8.] has remarked on how at operation one may see the neck in an oblique case, lying at first to the inner side of the cord, the body passing anteriorly to assume further down the canal a lateral ~~ring~~ position. He believes that if this were seen later, the sac would be located along the outer side of the cord entirely.

Histologically, it consists of a single layer of endothelium resting on a delicate connective tissue with intermingling of elastic fibres.

3. THE COVERINGS These are derived from the surrounding tissues of the abdominal wall, and vary with the site of the rupture. They have been indicated in the section on Anatomy.

CLASSIFICATIONS OF INGUINAL HERNIAE

Several Classifications may be adopted. One has already been indicated in the first section, according to the type of sac present. The second is on clinical grounds, and the third on anatomical.

CLINICAL CLASSIFICATION

1. Reducible.
2. Irreducible or incarcerated.
3. Strangulated.

Any of these may be either; (a) Primary or (b) Recurrent, that is recurrent after former operation.

ANATOMICAL CLASSIFICATION

1. Indirect Inguinal.
   (1) Complete Scrotal: (a) Congenital (b) Acquired
   (2) Inguinal: (a) Congenital (b) Acquired
2. Direct Inguinal: (a) Diffuse (b) Funicular

The term "scrotal" implies that the rupture anatomically extends into the scrotum, and generally to its base. "Inguinal", on the other hand, indicates a rupture outwith the boundaries of the scrotum. This is often known as a "bubonocele."

In regard to direct herniae, it is rarely possible, clinically to differentiate between a diffuse and a funicular sac. The former Fig. 21 is more generally bilateral than the latter Fig. 22 and presents as a wide bulge over the canal. Distinction clinically is not easy.

Special terms have been given to certain types of herniae, forming the basis of yet one more classification, such as epiplocele, enterocele, etc. This is not useful for general purposes, but is of value in association with other expressions. For example, a hernia could be described as a Primary Reducible Oblique Epiplocele.

There are many varieties of sac, many possible contents, differences in their coverings, and in their size. This raises the question as to the feasibility of one operation being adequate to all problems of repair. It is surely evident that it/

it is not possible to adopt a standard operation for this condition. Much has been said in late years of individualisation in the treatment of herniae, and a plea been submitted in favour of allowing the surgeon to select the type of operation best suited to the needs of each particular case. Others oppose this suggestion and urge a standard type of operation. They state that individualisation run riot is one of the main causes of recurrence, and that it is neither desirable or logical to permit the continued existence of half a hundred different operations for the cure of a common complaint.

The truth lies somewhere between the two extremes. At the moment, there are too many modifications of Bassini, Ferguson, Halsted, MacEwan, too many different methods of using fascial sutures, and too many points in dispute about the disposal of the sac, the best way to deal with the internal ring, and so on. On the other hand, bearing in mind the structure of a hernia and the many types encountered, it is surely not possible that any one can seriously advocate the use of one standard type of operation for its repair.

At least three operations are necessary to cover the requirements of repair. Simple herniotomy, simple herniotomy plus reinforcement of the fascia transversalis, and fascial sutures. I suggest in this thesis a fourth, the use of whole skin/

Fig. 22

DIFFUSE TYPE OF DIRECT HERNIA

Fig. 23
FUNICULAR TYPE OF DIRECT SAC

skin grafts inlaid to reinforce the canal and internal ring as a substitute for fascia. These operations cover all the requirements for repair. Individualisation comes in only in selecting the exact operation for each case out of the available three, and in minor points of technique during the performance of each.

A study of the structure of a hernia and the varieties of sac suffice to indicate that a standard operation is simply not practicable.

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C H A P T E R 9

ETIOLOGY OF INGUINAL HERNIAE

This has already been indicated to a certain extent at least, in previous chapters, but several points remain to be discussed.

The question is in two parts, the etiology first of the direct type, and secondly of the indirect.

DIRECT INGUINAL HERNIA

It has been stated that 25-30% of all inguinal herniae are direct and that of these, 60% are bilateral. [1.]

The protrusion is due to an acquired defect in the posterior wall of the inguinal canal, and, in a proportion of cases it may also be associated with the presence of an indirect sac. The acquired defect which permits the condition to develop may arise from several causes. Any condition which weakens the posterior wall may be regarded as predisposing in effect. The precipitating factors are those due to strain from any cause.

It has been shown in Chapters 3 and 4 that the integrity of the posterior wall of the canal depends upon the presence of a strong layer of fascia transversalis, with also an efficient conjoined tendon. The developmental or acquired anomalies/

anomalies of the conjoined tendon which, by partial atrophy or abnormal insertion produce a deficiency medially in the posterior wall are of high importance. The type of strain which leads to sudden slackening of the transversalis fascia, and relaxation of the conjoined tendon whilst increased intra abdominal pressure is maintained, is the most common precipitating factor.

Where there has been a previous appendicectomy through a gridiron incision with damage to the motor fibres of the lower part of the internal oblique and transversus abdominis there is an increased liability, [26. 27. 28.] and, in a proportion of people of asthenic build, natural muscle weakness, bilateral and generalised, predisposes to direct hernia formation.

Direct herniae differ in certain respects from the indirect. They are usually bilateral, are found at a later age, arenot common in females, and rare in children. These findings are due to differing etiological factors in the two conditions and will presently by analysed.

In a series of 849 cases investigated by Erdman [2.] 222 were bilateral and of these, 26% were oblique, 69.5% directs and direct associated with indirect 63.4%. In my own series of 104 directs, the condition was bilateral in 30. Coley [3.] in a review of 3000 consecutive herniotomies, found 636 bilateral cases, and of these 82 were direct with the large/

large preponderance of 465 bilateral indirects in the male, of which 255 were in adults. Despite these figures of Coley, it is generally accepted that direct hernia is more usually bilateral than indirect, and the reason for this lies in the fact that it is associated as a rule with a general muscle weakness. Andrews [4.] comments upon Coley's figures, and remarks "it is only reasonable to call attention to the large number of children in his series." Many of these were undoubtedly congenital, and, in any case there is reason to believe that Coley selects his cases and would thus tend to avoid many types of bilateral direct as they are so prone to recurrence.

Direct herniae are not common in soldiers, or in young healthy adults but in the spare type of subject [5.] and in those of poor physique. It is recognised that a large number of apparently normal people exhibit a "bulge" in the inguinal region which can be well demonstrated if the patient stands with the heels together and head and shoulders thrown back. In a series of 100 normal male admissions to the civilian wards of Woodend Hospital, Aberdeen, this bulge was sought for and found to be present in 25%. The average age of the patients was forty-six years. They were all admitted for treatment of haemorrhoids, removal of appendix, varicose veins and other conditions not related to the inguinal canal. In

a/

a series of 50 female patients admitted to the same hospital, and with an average age of thirty-two, only 4% showed any bulge, and in none was it so obvious as those displayed by the male subjects. In 100 soldiers admitted to Oldmill Hospital, Aberdeen, with fractures of the upper extremity or other conditions dissociated from hernia, a bulge was found in only 7%. The average age of the soldiers was twenty-six.

Erdman [2] found that 30% of a series of admissions without hernia displayed the bulge, but that 92.3% of direct herniae also exhibited it. Of a series of indirect herniae, 74.2% showed a similar bulge though to a less marked degree.

This bulge is due to muscle weakness, and is to be regarded as a stigma of the type of individual who may develop direct herniae.

When there is a large indirect hernial sac, dilatation of the canal and the abdominal rings so impairs the strength of these structures that the posterior wall also may give way and a bulge form medial to the deep epigastric vessels, the vessels separating two sacs, indirect and direct. This is known as the saddle bag or pantaloon type, or "direct-indirect."

In my series of 454 cases, it is found in 26 %. and in Erdman's series of 849 males, was present in 5.8%. Coley had 98 in adult males out of his 3000 cases, that is just under 3%. This variety of direct is entirely due to mechanical stretching of the parts due to the presence of the large or chronic indirect hernia.

The relative infrequency of direct hernia in the female is attributable to the absence of the spermatic cord. The female inguinal canal is a much more compact structure than that of the male, and the posterior and anterior walls in closer approximation to each other. In my experience, direct hernia in the female is rare in the multiparous women and, when present is generally bilateral.

Direct hernia has also a relationship to previous operation in the area. Reduction of a formed large indirect or femoral hernia, with consequent increase in intraabdominal tension along with weakening of Hesselbach's triangle caused by deep sutures is sufficient, according to Hesselbach to bring on a direct hernia. [29]

Any condition however, which leads to muscle atrophy predisposes to its development, and according to MacGregor [6]. during the 1914-1918 World War, ther was a twenty per cent increase in the incidence of hernia among German civilians due to starvation.

Finally, there is that type of direct hernia which is a result of a tear in the fascia transversalis due to a violent and sudden strain. This has been already discussed.

INDIRECT HERNIA

The etiology of this common complaint Fig. 23 has been the source of a bitter controversy between the exponents of Russels/

Russels congenital saccular theory, [7. 8. 9.], and those who adapt a contrary view stressing the importance of the inguinal sphincters and efficiency of muscles. Grey Turner states that whilst the saccular hypothesis of Hamilton Russel is held to explain most herniae said to be acquired, there must still be some added weakness or abnormal disposition of the muscle guarding the inguinal canal.

In addition to muscle weakness, however, it must be remembered that if the mesentery of the bowel is of normal length and situation, a loop of bowel cannot be brought down into the inguinal canal. In old age, there is often a slipping of the mesentery due partly to weakening of the muscle of Treitz which assists in maintaining the mesentery in normal position. This may be a factor in etiology in older people. In the younger age groups there must be either a degree of visceroptosis or else some abnormality in the length of the mesentery.

Incidence of Preformed Sac It has mentioned that the incidence of a preformed sac is 120 per 1000 subjects examined in aged people and 47 per 200 according to another authority, in middle aged subjects. Further it is noted by Banerjee that 59% of children who are normal have a patent peritoneovaginal process during the first four months of life, and 44% during the fifth.

Fig. 24

INDIRECT HERNIAL SAC WITH EXTRA-PERITONEAL FAT ADHERENT TO IT

Russel's Theory Russel [10] applied his view that indirect inguinal hernia owes its origin to a preformed sac, to the treatment of the condition, and believed only in the operation of simple herniotomy, for all but large cases.

He condemned the Bassini operations upon the following grounds:-

(1) Multiplicity of modifications of operation.
(2) Two theories of origin - congenital and acquired, and both types of case dealt with by the one operation.
(3) The uncertainty of results of operation, owing to the uncertainty of the underlying operation principle.
(4) The fatal facility for explaining recurrences as being due to inherent muscular weakness.
(5) Misuse of the truss, especially in children.

These words were written in 1906 [11]. and the position has not substantially changed in many centres to this day.

Russel stated that his saccular theory dealt with all of the above criticisms, in that it:

(1) Gave one sound operation of proven good results.
(2) Gave one theory of origin based on observed facts.
(3) Gave a certainty of good results if the operation was faultlessly performed.
(4) Gave recognition to the fact that if failure took place, it was due to faulty operative technique.
(5) Abolished the truss, save where operation was contra-indicated or declined.

He did, however, agree that where the condition is of long standing, with muscle weakness, a repair is indicated.[7].

In/

In childhood be believed that there is only one cause of any inguinal hernia, and that congenital. He also agreed that direct cases are always due to muscle weakness.

There can be no reasonable doubt but that in childhood all indirect herniae are congenital and owe their presence to a patent peritoneo-vaginal process. In adults, it must also be admitted that a substantial number of people have a similar patent sac. But, in adults, it cannot be accepted that all cases of indirect herniae are due to this cause. There must be at least some precipitating factor.

Strains On Pages 166 to 170 , the effects of strains on the inguinal canal have been considered in detail and the response of the canal to the presence of a preformed sac discussed. It is emphasised that there must be a reason other than a congenital sac for indirect herniae developing quite late in life, and in people of good physique. The role of the inguinal sphincters has been indicated and the parts played by the muscles in preventing development of a hernia analysed.

Briefly, it may be repeated that a congenital sac is harmless and not per se productive of a hernia so long as muscle tone and co-ordination remain efficient. Muscle weakness from any cause, accompanied by often repeated mild stimuli, or one or more severe strains, may cause a part of a viscus to be protruded with formation of visible hernia. In the absence/

absence of a congenital sac, muscle inco-ordination as a result of a sudden slip or thigh flexion whilst there is maintained an increased intraabdominal strain, is enough to cause a pouching of parietal peritoneum into the inguinal ring, and similar further strains will increase the protrusion of the sac until ultimately it also acquired contents. One sudden strain cannot by itself cause a hernia other than the special type known as the "traumatic hernia." It is a well known fact that the finger cannot be introduced by force through the internal ring save in the presence of a patent peritoneal sac. If such a strain could cause hernia the condition would be universal and the most common variety would not be the inguinal. The ideal sites under these circumstances would be the oesophageal orifice of the diaphragm or the femoral ring. Yet, in men these herniae are by comparison with the inguinal type, rare. The most important factor in etiology of indirect inguinal hernia is the presence of a patent congenital sac.

Other factors may increase liability to hernia formation and others again may act as precipitating factors, but the patent sac is THE most important single reason for the development of the large majority of inguinal herniae.

Starvation Factors such as starvation, debilitation, anaemia, or any condition causing a lowering of muscle tonus will reduce/

reduce the efficiency of the sphincters and predispose to weakness of the rings and onset of rupture. In Germany during the last War, there was a 450% increase in incidence of inguinal hernia in certain hospitals in 1918 as opposed to 1914. This was considered to be due to food shortage, subsequent loss of subcutaneous fat, and muscle flabbiness. [12.]

Heredity The question of a hereditary predisposition has been discussed by Eccles, and a "constitutional diathesis" [13.] by MacGregor. According to Eccles, quoted by MacGregor, 25% of all people suffering from hernia give a definite history of familial predisposition pointing to a transmitted strain of muscular deficiency as typical as a facial feature of birth mark.

In my experience, this is not so. All of my 350 cases of indirect hernia, and also the 104 patients with direct were examined from this point of view. Only 9% gave a familial history, and, in view of the fact that 2% of all recruits during the 1914-1918 World War [5.] gave a history of being, or having been affected by hernia, the probability is that the figure of 9% could be explained simply by the frequency of the condition.

Importance of Muscles Murray [14.] compared the sacs of infants and those of adults who were considered to have congenital sacs, and observed marked differences. In infants, the/

the sac in characteristically long, narrow and constricted at its proximal end. In adults and older children he found that many sacs were simple conical processes evaginated through a relaxed abdominal ring, and not resembling in any way true congenital types. Many of these had a recent history and the type of sac could not be attributed to simple mechanical stretching by a contained viscus.

It has also been observed by Edwards [15.] and MacGregor [13.], and many others that military recruits called from sedentary occupations have an initial high incidence of hernia during the early period of training, but, that if the muscles can withstand exercises and marching for a few weeks, the effect of training makes development of later hernia unlikely. The importance of the muscles is recognised by the Service Authorities, and surely, with evidence to hand, they must be regarded as playing an important part in the etiology of the condition.

Frost estimated that 11.7% of all railroad employees have some form of inguinal hernia. [30.]

From an occupational point of view, the condition is more common in those who have to adopt a stooping position frequently, or with slight flexion of the thighs, impose their weight against an obstacle. This also is difficult to reconcile with the saccular theory of hernia, as it is improbable that/

that congenital sacs are more common in such workers. The point is, that stooping or heavy work with flexion of the thighs causes the inguinal sphincters to work at a mechanical disadvantage.

A leading editorial article in the American Journal of Surgery [16] has pointed out the attitude of industry and insurance companies to hernia and emphases that they regard the condition as being due to muscle weakness on the part of the individual - except of course in true traumatic herniae - and these organisations attach considerable importance to the preformed sac theory. The effect of strain at work is dismissed as very subsidiary factor in the etiology.

The weight of evidence however, supports the theory that whilst a number of cases owe their origin to a patent congenital sac, a large number are due to other factors, and of these muscle inco-ordination and strain are the more important. Nevertheless, in childhood the higher proportion of cases are congenital in origin, and in infancy, all are.

ETIOLOGY

SPECIAL TYPES OF INGUINAL HERNIA

TRAUMATIC

True traumatic hernia is very rare indeed, and in order to be diagnosed, must fulfil certain requirements.

1. There must be a proved relation to an accident by early examination.

2. It must have appeared early after the accident and be accompanied by pain.

3. It must be proved that it did not exist before the accident.

4. It must be accompanied by considerable damage to tissues.

5. There must be a clear cut history of trauma either by a blow, a fall from a height, or laceration by an instrument.

These requirements are to be fulfilled before the condition can be considered traumatic in origin. [17.]

This type of hernia is excessively rare but does exist, and trauma must therefore be considered an etiological factor in at least a proportion of cases.

EXTRA SACCULAR HERNIAE

This type of hernia relates to a sac, but the affected viscus is either definitely outside it, or so attached that simple reduction is impossible. The organs most commonly affected are bladder, caecum, appendix, ascending colon, sigmoid colon or a combination of these. There may be an associated saccular hernia. For the hernia to be extrasaccular the organ involved must slide down from its normal position and drag with it the related parietal peritoneum. The condition may be congenital or acquired, due to several causes, and vary somewhat according to the viscus affected.

Certain basic principles remain common to all sliding herniae, and these are first discussed.

Congenital Extra Saccular Hernia

1. In foetal life, a fold known as the plica vascularis runs from the mesorchium along the posterior abdominal wall to end in the caecum or appendix, mesentery or ileum. Gubernacular fibres may pass in this fold, and the testicle in its descent pull upon one of these viscera to form an extra saccular hernia.

2. The posterior surface of the embryo caecum, appendix, ascending colon or bladder, may develop adhesions to the peritoneum covering the yet undescended testicle, and be dragged down with it. 16.

Acquired extra saccular Hernia

1. There may be a condition of enteroptosis predisposing to hernia formation. In the case of the caecum and ascending colon, sigmoid, or in some cases, terminal ileum, this fact with the presence of an incomplete covering of peritoneum to the viscus, makes the retro-peritoneal area lie in closer proximity to the internal ring, and predispose to prolapse through it.

2. A large indirect inguinal sac may, during the period of its enlargement, drag down the parietal peritoneum of the posterior abdominal wall and with it caecum, colon or appendix, occasionally also the bladder.

The majority of cases occur on the right side, but Foerster [19] collected fifty four cases on the left side associated with transposition of the viscera.

EXTRA SACCULAR HERNIA OF THE BLADDER

In the special case of the bladder the organ may be dragged down by traction of a large direct or indirect sac, most often the former. But one other cause peculiar to the bladder/

bladder depends upon distension of the viscus associated with prostatic hypertrophy and urinary retention. Bladder dilatation and hypertrophy may be followed by sacculation of a part of the wall into the posterior wall of the inguinal canal. In indirect cases as the peritoneum of the bladder closely attaches to its posterior and inferior surfaces, and every sac increases at the expense of parietal peritoneum, it is obvious that it will gradually come to drag the attached bladder down with it. Thus a portion of the organ ~~will~~ may ultimately form the inner and posterior part of the sac.

Any factor which dilates the hernial rings or increases the volume of the bladder favours the development of the condition.

It is generally found in adult life and old age though rarely in young children. Watson [31] found thrity cases in children under 12 years. This is extremely rare.

EXTRA SACCULAR HERNIA OF THE CAECUM

ETIOLOGY

The etiology of this condition is discussed in detail in Chapter 19 but the main points may here be conveniently summarised.

1. Persistance of the ascending mesocolon.
2. Possession of a mesocaecum.
3. Adhesion of the developing caecum to the descending testis.

4. Abnormally long mesentery of the sigmoid colon.

5. The normal close proximity of the caecum to the internal inguinal ring in the erect posture.

6. General visceroptosis of the abdominal organs.

7. Overdistension of the bowel.

8. By Basculation, that is where the caecum enters the sac secondary to another organ.

Hernia by Basculation Here the proximal end of the ascending colon, or terminal ileum, or perhaps omentum enters a formed hernial sac. With further descent of the affected viscus the caecum is secondarily drawn into the sac, forming an angle with the wall of the primary viscus.... hence the term Bascultation.

There may be a combination of any of the above factors, but in all cases of true sliding hernia, that is extrasaccular herniae, the primary cause is a slipping of the posterior parietal peritoneum on the underlying tissue. The sequence of events may be described as first, slipping of the parietal peritoneum, secondly traction on, or ptosis of the caecum, descending or ascending colon or sigmoid, descent of the affected viscus and finally its partial deperitonization.

True sliding or gliding involve chiefly the caecum or sigmoid colon.

A secondary factor in development is increased intra abdominal pressure which directs the caecum to the internal inguinal or femoral rings.

After the development of the condition other organs may find their way into the related sac. Omentum and small intestine is frequently present, and, on the right side, the appendix. These may be affected either by traction through adhesions to the primary viscus, or merely graviate naturally because of the patent sac and patulous rings.

Once started the condition is progressive, and is aided by the sheer weight of the intestinal contents.

Further details concerning the etiology of this type of hernia are given in the Chapter dealing with Sliding Hernia, Chapter 19.

RECURRENT HERNIAE

The problems of recurrence are discussed throughout this thesis but may be summarised as due to one or more of the following factors:

1. Imperfect choice of operation.
2. Bad technique during the performance of the selected operation.
3. Badly chosen operation badly performed. [32.]
4. Too early freedom from bed after operation.
5. Too early return of strenuous work. Twenty to twenty-five per cent. of all men are obliged to return to conditions of work which predispose to development of hernia, and thus also of recurrence. 20.
6. Lack of co-operation on the part of the patient during the post-operative period.

7. Presence of some constitutional predisposing factor such as chronic bronchitis, bronchiectasis, phymosis, prostatic hypertrophy, or chronic constipation.

8. Post-operative sepsis.

9. Immediate acute or subacute post-operative bronchitis or pneumonia.

10. Violent straining during return from anaesthesia.

Of all these, the most common are the first two, the choice of operation, and the excellence of its performance.[21]

Certain of these factors in recurrence are outwith the surgeon's control but of those which are under his control, the following points may be listed as being most frequently concerned:

1. Failure to eliminate the sac in its entireity, and at a sufficiently high level.

2. Failure, efficiently to narrow the internal ring and reinforce the posterior wall of the canal. 22.

3. Failure to observe the presence of a second sac on the affected side.

4. Use of non-absorbable sutures provoking onset of late sepsis.

5. Deep or superficial infection of the wound area.

6. Failure to forestall post-operative chest lesions by the routine use of $C.O._2$ and Oxygen inhalations were possibility of such complications are anticipated. (See section on anaesthesia.).

7. Selection of case suitable for operation. This is mentioned as being of importance by Cole. 23. 24. Here is a clue to the success which he claims in his treatment of herniae. In my view, cases should not be selected with a view to collecting satisfactory statistics. Any competent surgeon could then gather large series of successful/

successful cases were he to choose only healthy young adults with small ruptures. The possible benefits of operation should not be witheld from anyone who desires them, unless there are obvious contraindications to operation, such as phthisis, heart failure or other grave systemic calamity.

8. Direct herniae are more prone to recurrence then indirect for reasons which are made clear in the sections on anatomy, and operative treatment. 24.

Age bears a certain relationship to recurrence also. Murphy [25] found in an elaborate analysis, a recurrence of just one per cent for cases under a year old, rising to over nine per cent for people over sixty. These figures are from one of the foremost clinics, and for indirect herniae only. It is reasonable to suppose that they may be much worse in many others. The fact emerges that recurrence increases with age.

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C H A P T E R 10

SIGNS, SYMPTOMS AND COMPLICATIONS OF INGUINAL HERNIAE

INCIDENCE

Of 160,545 men in the London district recruited during the 1914-1918 World War 1.1% were unfit for Military service in any category owing to gross inguinal hernia. In 1907, of 3162 adults investigated in workhouses, 2% attributed their pauperism to the incapacitating effects of inguinal hernia.[14]

SEX INCIDENCE

There are 98.9% in males, and 1.1% females - according to Fallis.[1] In my own series, 96 % were in the male.

AGE OF ONSET

The condition is found at all ages from birth to the tenth decade. Indirect herniae are found at a younger age on the whole, than are directs, which are more common in men over forty.

OCCUPATION

In a large American Series, 1. 82.5% had engaged in work involving heavy lifting or working with heavy weights. It is/

is accepted that very many men give a history of strain whilst at work. In my own series, 29.6% give a definite history of strain. In none was there a true proven association such as required legally in the diagnosis of traumatic hernia, but the patients were convinced that the strain was a factor in etiology. Frost [11] estimated that 11.7% of all Railroad Employees had some form of inguinal hernia.

RELATIVE INCIDENCE OF DIRECT TO INDIRECT

In my own series, 22.9 % were direct and the remainder indirect. Fallis, in 1600 cases, had 15.7% direct, the remainder indirect. The latter are much more frequent.

BILATERAL

Of indirect cases, Fallis [1.] had 28.3%. I had 10% which were bilateral. Directs are more commonly bilateral than indirect. 28.9 % of 104 direct cases in my series, were bilateral.

CLINICAL SIGNS AND SYMPTOMS

1st Stage of Development This is the phase before any swelling is apparent and the hernia is in process of forcing a passage through the internal ring. Here there is often moderately acute pain over the ring aggravated by exercise, relieved by rest and lasting for varying lengths of time. In addition/

addition there is often some generalised abdominal discomfort, often in the epigastrium and sometimes referred to the back. At this stage evidencesof hernia are purely subjective and no objective signs can be detected. With the onset of the second stage, that is when the hernia has passed the internal ring there may be visible swelling over the canal.

Second stage of development As a rule, the patient notices some discomfort which attracts his attention to the part in which the abnormal swelling is found. This swelling at first is present only intermittently, disappears on lying down and is aggravated by exercise or standing up.

There is frequently a sensation of weakness of heaviness in the inguinal region, and there may have been a bursting pain or tearing feeling a short time prior to the onset of a swelling. Many are at first unaware of any abnormality other than a small painless bulge for which treatment may not be sought until more serious signs have developed.

The swelling may be at any age from early infancy to late adult life, but, having appeared, is progressive though symptoms may be few. Under exceptional circumstances, it may cure spontaneously.

According to Cosens [12] who examined 20,000 soldiers, the rectus muscle on the affected side is often more rigid than the one on the wound side. He also suggests that palpation over the weakened rings produces pain and often a referred pain to a point above the umbilicus.

Two types of pain are associated with the hernia, a local discomfort and a colic referred to the hypogastrium or periumbilical area. They are aggravated when the hernia is "down". This colic is associated with the development of constipation and dyspeptic symptoms, and may become severe following incarceration.

Rarely other phenomena may be observed, noticeable hyperaesthesia over the testis on the affected side or more rarely still pain referred along the ilioinguinal and genito femoral nerves to the side of the scrotum, major labius, penis or Scarpa's triangle.

An inguinal hernia forms, when reducible, and uncomplicated, a soft and compressible external swelling, which when reduced plops back into the abdomen with a regurgitation of air or faecal contents causing a gurgling noise and conveying a characteristic sensation to the examining finger.

Third stage of Development. Here the hernia has passed the external ring and extends into the scrotum or major labium. Pain is often less severe in the absence of complications but there is frequently a sense of heaviness in the part which varies with the size of the swelling.

In massive cases there may be pain and gastro intestinal disturbances often due to constipation. If the abdomen has become pendulous there may be a dragging sensation

which can be referred to viscera still remaining in the abdomen.

The patient must always be examined both prone and standing erect. In the early case the pubic spine can be felt below and outside the swelling. This is the characteristic differential diagnostic point from femoral hernia, and is probably of most value in the female.

Impulse on coughing. When small, the dimensions of the hernia and the condition of the canal can best be ascertained by the examining finger invaginating the scrotum. At this point when the patient coughs, a definite expansile impulse is transmitted to the examining finger and the hernia bulges down on to its tip. This test has been criticised as being but a wanton assault on the integrity of the canal and external ring. It is stated to be unjustifiable and calculated more to inflict damage than to supply information. But, whilst repeated examinations may ultimately stretch the canal, and this manoeuvre has been used to produce hernia and escape military service, yet, as applied clinically can surely be of little danger. The information obtained is worth while and useful in establishing the differential diagnosis.

Relation of hernia to testicle and cord. When the hernia is larger and occupying the scrotum, there is a fullness along the line of the canal and a mass within the scrotum which is

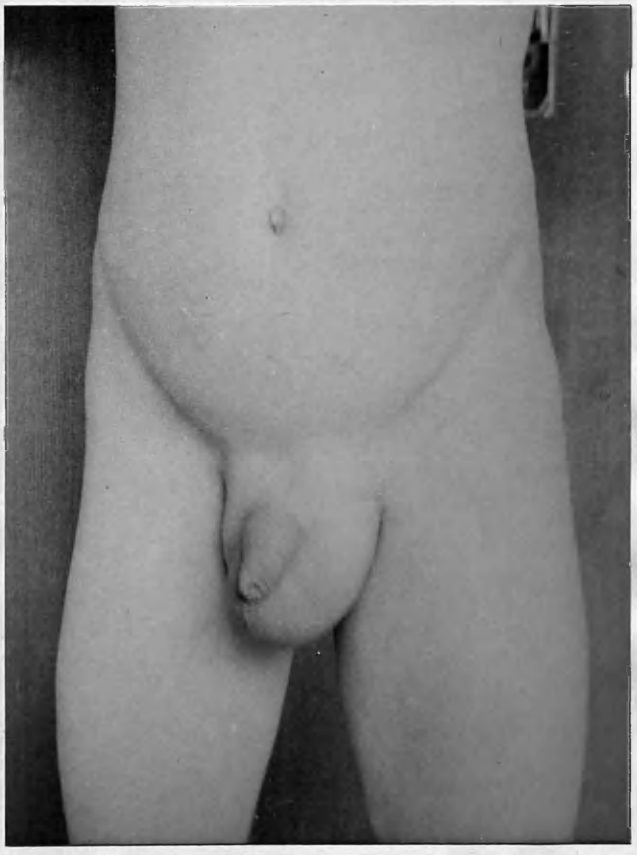

Figure 25.

Typical Indirect Inguinal Hernia.

larger after exercise or when standing erect. This mass most frequently lies above and in front of the testicle with the structures of the cord behind it. When reduced, the canal and abdominal rings are found to be dilated and there is a thickening of the cord beyond the external ring due to the presence of the sac.

Where the swelling extends into the scrotum, it can readily be differentiated from any form of testicular swelling or hydrocele, by grasping the cord just distal to the external ring. If the fingers and thumb can meet separated only by skin and cord, the condition is not a hernia.

It may be difficult to distinguish with certainty between direct and indirect hernia. It is said that it is possible by invaginating the scrotum to feel the epigastric artery, and locate from that on which side the hernia lies. This may be possible, but, in my experience it is an extremely difficult thing to do with any degree of accuracy.

A point worthy of note is that in young children, a hernia may not be opaque to transillumination. In adults, however, it always is.

Properitoneal Hernia. The symptoms are often indefinite and diagnosis is rarely made before operation. There is usually no swelling in the inguinal region to indicate hernia.

A fullness over the iliac fossa associated with an

undescended testis should lead to the condition being suspected.

Interstitial Hernia. This may be diagnosed clinically as it is usually fairly superficial and the swelling may be palpated.

Inguinal Hernia in Women. Examination of the canal is not easy and the external ring is difficult to detect. There is often a fullness over the site of the ring which is most clearly shown when the patient strains. In obese subjects the diagnosis is especially difficult.

Massive Hernias. These are usually irreducible and may contain almost any single, or any combination of the abdominal viscera. In males the penis may disappear within the swelling and urine excoriate the skin. In the female some of the pelvic viscera may be found and pregnancy within a herniated uterus has been reported.

DIFFERENTIAL DIAGNOSIS OF INDIRECT TYPE.

Diagnosis of Inguinal Hernia from other Diseases.

1. Differential Diagnosis of Complete Reducible Inguinal Hernia.

In the male the conditions that most frequently cause enlargement in the scrotum which diminishes on pressure or may disappear, are, scrotal hernia, varicocele and congenital

hydrocele.

In the female the diagnosis of inguinal hernia is much easier than in the male. The only reducible swelling likely to be encountered in the female is varicosity of the labial veins, which may appear during pregnancy. The differential diagnosis between complete inguinal hernia and femoral hernia is usually simple in either sex.

2. Differential Diagnosis of Complete Irreducible Inguinal Hernia.

In the male, an irreducible scrotal tumour may be a scrotal hernia, a hydrocele of the cord or of the tunica vaginalis, an inflammation or newgrowth of the testis, an ectopia of the testis, or a hematocele.

Irreducible Hernia in the Female.

An irreducible inguinal hernia in the female must be differentiated from irreducible swellings of the labium majus, such as a cyst, which may be glandular; a hydrocele of the canal of Nuck; abscess, and a fibrous tumour. Hydrocele of the canal of Nuck is more common in children than is generally supposed.

Diagnosis of Incomplete Inguinal Hernia.

1. Differential Diagnosis of Incomplete Reducible Inguinal Hernia.

In the male, the diagnosis of an incomplete reducible hernia is usually easy. The only condition which may cause

confusion is a funicular hydrocele. Here the processus vaginalis is obliterated near the external ring, but is open above, communicating with the peritoneum. This is a rare variety of hydrocele, and, although reducible, is unaccompanied by other symptoms of hernia. A funicular hydrocele may occur in the canal of Nuck.

Incomplete reducible inguinal hernia, or bubonocele, must not be mistaken for a reducible femoral hernia. In males this is less likely to occur, but in females confusion is probable especially if the patient is obese.

2. Differential Diagnosis of Incomplete Irreducible Inguinal Hernia.

This must be differentiated in the male from the following conditions: An incompletely descended testis, a hydrocele of the processus vaginalis of a partially descended testis, an encysted hydrocele of the cord in the inguinal canal, a dermoid cyst of the inguinal canal, lipoma of the cord, and malignant growth of the cord.

Malignant diseases of the cord are rare. They present a characteristic hard swelling, that may have followed an injury, and steadily increases in size. Metastasis may extend very early along the cord into the abdomen.

In the female, an incomplete irreducible inguinal hernia must be differentiated from the following conditions:

hydrocele of the canal of Nuck, lipoma and other tumors of the round ligament, and dermoid cyst in the inguinal canal.

Hydrocele of the canal of Nuck is a tense, fluctuating tumour which cannot be forced out of the inguinal canal. If it is large, it may be translucent.

In Both Sexes.

Incomplete irreducible inguinal hernia is to be differentiated from the following conditions that affect both sexes: inguinal adenitis, abscess in the inguinal region, psoas abscess, exostosis of the os pubis, aneurysm, lymphogranulomatosis, and in tropical regions, climatic bubo.

The more important of these conditions are considered in a little more detail.

The diagnosis must also be made:-

(1) Between direct and indirect inguinal hernia.

(2) Between inguinal hernia and other diseases.

Then, secondly, there is the differential diagnosis of complete inguinal hernia.

(a) Reducible.

(b) Irreducible.

and finally, the differential diagnosis of incomplete inguinal hernia.

(a) Reducible.

(b) Irreducible.

1. Inguinal Adenitis. Enlarged glands may be confused with a hernia which does not descend to the scrotum, but they have no true impulse on coughing, and are merely jerked forwards. They lie at a lower level, do not emerge from the inguinal canal, and lack the characteristic pyriform shape of the hernia.

2. An encysted hydrocele of the cord is smooth, tense and globular, has no impulse on coughing and is fixed by traction on the testicle.

3. An undescended testicle lying in the canal forms a bulge which lacks impulse on coughing, but does give a characteristic sensation on pressure to the patient, and has its own characteristic form. It is always accompanied by a hernial sac, and this may form a true hernia existing in conjunction with the testicle. If the hernia is reducible, the two conditions can be differentiated. There is of course, absence of a testicle from scrotum on affected side.

4. Abscesses coming from within the abdomen may present into the inguinal canal, and even at the external ring. They can occasionally be reduced with a gurgle, but are generally fluctant and associated with tuberculous disease either in the spine or in the abdominal glands. They are more likely to be confused with a soft lipoma, but I have seen several where they were difficult to distinguish from a small indirect hernia. Pus within the canal from a cold

Figure 26.

Typical Indirect Hernia associated with lipomata.

abscess is under a degree of tension from the overlying external oblique aponeurosis and fluctuation may be difficult to elicit.

5. Lipoma. Fatty tumours presenting into the canal are often associated with a small hernia, and by their presence dilating the canal predispose to later hernia. They do not have a true impulse on coughing.

6. Complete scrotal herniae bear a superficial resemblance to hydrocele, variocele, or testicular tumours. Inspection of the cord at the external ring and palpation at that point should clear up the matter. Rarely a hydrocele may extend right up the cord and through the internal ring from the scrotum. This is rare and when present, transillumination will clarify the position unless repeated tappings have caused a haematoma or markedly increased the thickness of the walls.

7. Hydrocele. A hydrocele is irreducible, globular, tense and elastic, gradual in onset, progressive in growth, dull to percussion, usually translucent to light, lacking in an expansile impulse on coughing and generally confined to the scrotum.

Keller[13] reported a case which illustrates the danger in mistaking a hernia for a hydrocele: A man, aged fifty-eight years, was tapped twice with a trocar and cannula and only a little blood obtained. Severe pain developed soon

after, and at operation ten hours later a strangulated hernia was found with haemorrhage in the sac. Death from peritonitis followed on the fourth day.

DIFFERENTIAL DIAGNOSIS OF DIRECT HERNIA.

The condition must be diagnosed from all swellings within the canal.

1. Indirect Inguinal Hernia.

Confusion with a small indirect sac is common, but some indication may be found after examination of the canal by a finger into the invaginated scrotum. The indirect sac on coughing will strike the tip of the finger in a characteristic fashion, whilst the impulse is more expansile. In a direct sac the weakness of Hesslebach's triangle can be detected by the finger. The impulse is less expansile and most diffuse. Finally, the direct type is more often bilateral. Little assistance is had by attempting to establish the relation of the sac to the deep epigastric artery.

2. Varicocele. The dilated tortuous veins can be detected coursing up from the scrotum and causing thickening of the cord outwith the confines of the canal.

3. Hydrocele of the cord. The tumour can be rendered tense by exercising traction on the cord. It lacks a true impulse

on coughing and is globular in shape. It may be possible to demonstrate fluctuation. It does not reduce in size on lying prone and increases progressively with passing of time, yet remains free from the pain of incarcerated hernia.

4. Cold abscess within the canal. This has been indicated above.

5. Lipomata within the canal. These do not reduce, are painless, grow progressively and are found mainly in persons of obese habit.

6. Undescended testicle lying within the canal. The characteristic shape and presence of testicular sensation have been referred to.

PROGRESS AND COMPLICATIONS OF INDIRECT TYPE.

A hernia once present, tends to increase in size in the absence of active or paliative treatment, but for a varying length of time will remain reducible. This is to say, the contents can be returned to the abdominal cavity by manual manipulation, or change in posture.

REDUCTION OF THE HERNIA.

This process is known as taxis, and is performed by maintaining steady pressure with the fingers of one hand upon the swelling, at first near the neck, and attempting to persuade the contents to return to the abdominal cavity.

The manoeuvre is best performed with the patient lying prone and the head low with the feet elevated. The inguinal region should be relaxed, and this is conveniently ensured by having the thighs slightly flexed, abducted and externally rotated. The patient is instructed not to strain during the manipulation, but to breathe steadily and gently.

The neck of the sac is steadied with the fingers of one hand whilst the other grasping the swelling maintains gentle pressure upwards, backwards and outwards, in the line of the canal. When a part of the swelling has been reduced with a characteristic sensation back to the abdomen, the manoeuvre is repeated until the entire rupture has disappeared.

IRREDUCIBLE HERNIA.

With the development of adhesions within the sac, the hernia becomes irreducible. These adhesions most frequently involve omentum, but may also be associated with intestine, small or large.

The symptoms and signs remain substantially as for a reducible hernia, save that reduction is no longer possible, and there is often increase in local discomfort, constipation, indigestion or a "dragging" sensation in the part.

Impulse on coughing may not now be elicited. There may, however, remain some slight expansion on coughing for a variable period of weeks or months.

The hernia may show periodic mild attacks of local

inflammation. These are frequently due to trauma of the contained viscus, indiscreet attempts at reduction by taxis, and mild infection from the inflamed bowel.

In severe cases the classical signs of inflammation are seen, with swelling, heat, tenderness and redness and there is some constitutional upset with pyrexia and nausea. The inflammation may subside or, rarely, go on to abscess formation. The condition has a superficial resemblance to strangulation, but there is no obstruction, there is early pyrexia, and no associated shock; nor is the scrotum so tense and hard as in strangulation.

The appendix may be found within the sac, and be the seat of an acute attack of inflammation. This may go on to abscess formation. The condition is clinically similar to that of ordinary appendicitis, but modified only in the site of local tenderness.

A massive hernia may be irreducible owing to factors other than adhesions. If the neck of the sac is unyielding and the mouth not greatly dilated, it may be mechanically impossible to reduce the herniated viscera back to the abdomen. Further, in long standing massive cases, the abdominal cavity may not be able to reaccommodate the organs so long located in the sac. In such cases there are generally adhesions which make reduction even more difficult.

Irreducibility is the prelude to obstruction.

OBSTRUCTION.

Here, owing to increase in the size of the hernia, to fibrous contraction of, or around, the neck of the sac, to kinking of the bowel preventing the passage of faeces through the sac, or to the accumulation of flatus, there is an obstruction to the free passage of intestinal contents.

This is associated with violent colicky pains, referred to either the hypogastrium or periumbilical areas depending upon the site of the obstruction. Vomiting follows at a later or earlier date depending upon the site of the block, earlier when ileum or jejunum is implicated. The higher the obstruction, the more acute the general reaction, and the worse the prognosis.

In the early stages, constipation and pain is the rule, with little elevation of temperature or pulse rate, but, with the progress of the disease, temperature and pulse rise, vomiting and dehydration increase, the general condition deteriorates, and the local condition shows swelling, tension and pain. The hernia is hard to touch, but not so tense as when strangulation is present.

This condition is often described as incarceration.

STRANGULATED INGUINAL HERNIA.

If incarceration is not relieved, strangulation will follow, it may however, take place rapidly and without even any history of hernia having been formerly present. In the

presence of a patent congenital sac, the gut may descend and strangulate within hours. I have personally examined one man, Case , at 11.0 a.m., noted the absence of hernia, and operated on the same day at 3.30 p.m. for strangulated oblique inguinal hernia. The rupture came down according to the patient, at 2.0 p.m. after a mild twist whilst coming down some stairs in his house.

The incidence of strangulation is, according to M'Iver [7]. 2-4% of all inguinal herniae, whilst in a series of 6892[8], cases of acute intestinal obstruction, 3,267 were due to this calamity. It is also eight times more common in men than in women[9].

Prognosis. Over 2000 persons die annually in Great Britain from strangulated hernia. The prognosis becomes more grave in direct proportion to the time interval before operative treatment. Frankau[9] found a death rate of 6% when treated within twenty-four hours of onset, rising to 36% on the 5th day, with an average death rate of 25%. When gangrene is established and resection of gut becomes necessary, the death rate for a series of 105 cases was 42.8%. Other factors influencing prognosis are:

(1) The age and general condition of the patient.

(2) The management of the case after operation.

(3) The actual operative technique employed.

(4) The type of anaesthetic used.

The question of treatment is discussed elsewhere.

If strangulation, that is interference with the blood supply to the contained viscus, as a result of pressure on the neck of the sac, takes place, there is usually also obstruction.

Site. The site of strangulation is at the neck of the sac or just below it. There may also be thick bands of fibrous tissue within it. Occasionally the old scar tissue nearby, the edge of Gimbernat's ligament, or the lateral edge of the rectus sheath may be the constricting mechanisms.

Signs and Symptoms. The signs and symptoms are those of intestinal obstruction with the addition of local signs characteristic of the underlying pathology within the hernial sac. Moist gangrene of the affected viscus is established, there is early and acute peritonitis, intense inflammation within the sac, possible perforation of the gut wall, later faecal fistula, and congestion of the overlying scrotal and inguinal skin.

The classical signs of acute intestinal obstruction are seen with sweating, coldness, prostration, nausea, sickness going on to faecal vomiting, abdominal distension, visible peristalsis, absolute constipation, early generalised abdominal pain, with later lessening in severity associated with gangrene of the bowel, peritonitis, thirst, dehydration, intense toxaemia, confusion and death.

Many cases are seen where the symptoms are modified or less severe depending upon the affected viscus and the

degree of strangulation. According to Maingot[10.] small intestine is present either alone or with omentum in 85% cases, omentum alone in 8%, colon in 6%, pelvic organs or appendix in the remaining 1%. If omentum only is present, there are no signs of intestinal obstruction. There is less pain, nausea, vomiting, shock and constipation. Abdominal distension is absent at first, and develops only later with the onset of generalised peritonitis. The condition by then is as serious as where bowel is involved.

The rare types of Richter and Littre's herniae are modified also by absence of signs of obstruction at first, and shock is markedly less intense. Peritonitis later will develop if the conditions are untreated, and, as the diagnosis is obscure and no visible hernia can be seen, they are easily missed clinically. They are thus potentially more dangerous than the more obvious type of case.

Treatment. The acute pain of strangulated hernia is partly due to spasm of the involuntary muscle of the strangulated coils of gut. If this spasm can be relieved, pain likewise may be lessened, and reduction facilitated. Accordingly it has been suggested[2.] that atrophin sulphate in doses of 1/50 grain should be used as a routine pre-operative measure. In obstructed cases where strangulation is not present the same method can be used to facilitate reduction. In my view, this treatment should not be permitted to supplant

operation as has been suggested. It may be of value in relieving pain, but operation is indicated for all cases of this nature. The operation should be confined to doing as little as possible compatible with saving life, and should be performed under local anaesthesia.

Especially in the aged, treatment should be confined to freeing the constriction and reducing the hernia. No other more complex measure is indicated.[6.]

Rarely, spontaneous cure is seen as a result of faecal fistula developing in the scrotum. This was a method of treatment deliberately practised in early days, and one successful case is reported by Knyveton.

The possibility of reducing a strangulated hernia en masse by ill-advised attempts at taxis, or tearing the gut by forcible efforts at reduction, have all been described, and are dangers sufficiently real to be guarded against.[4.] They are discussed in full elsewhere.

It is of interest to note that cases have been reported of strangulation at the age of ninety-seven treated successfully by resection of gut and end to end anastomosis.[3.] Similar cases with successful results after operation involving resection of gut in infants have been reported and Estor[5.] collected 225 examples in children under two years of age with a mortality of 23%. Jopson[5.] reported one successful result in an infant of two weeks. Despite these

surgical curiosities, no more should be attempted at operation than is essential to save life. If gut is obviously non-variable it must be resected, but this must be an operation of absolute necessity before being justified.

One rare form of strangulation is found in the so-called Maydl's Hernia. This is one of W formation, with two loops in the hernial sac and an intervening loop in the abdomen. This latter loop may become strangulated owing to compression of its mesentery. The condition is excessively rare and has been called "retrograde strangulation".

PROGRESS AND COMPLICATIONS OF DIRECT INGUINAL HERNIA.

The hernia increases in size, though never assumes the grotesque dimensions which may be shown by some old-standing indirect cases. It remains surprisingly free from pain and the patient complains rather of a feeling of weakness in the area. Complications are few, and it has been stated that there is no need to operate on direct herniae owing to the absence of strangulation. Both incarceration with obstruction, and strangulation, however, may be exhibited within the funicular type of direct sac, though admittedly rarely, if ever, in the diffuse. When strangulation does take place the external ring is often the site.

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CHAPTER 11.

PATHOLOGICAL AND ANATOMICAL CHANGES IN THE INGUINAL CANAL AS A RESULT OF INDIRECT HERNIA.

So long as a hernia does not descend to the scrotum or increase in size, no deterioration need follow in the tone of the muscles but some impairment of efficiency at the internal ring is probable. If the hernia is reduced and the sac alone remains no significant changes will occur. Muscle stretching and anatomical distortion are sequelae of any chronic distension of the canal and rings.

Changes also are found in the fascial layers and sac.

CHANGES IN THE MUSCLES.

The initial response of the muscles to the presence of a small hernia is hypertrophy, and an effort is made by them to overcome the pressure of the contained swelling. This is rarely successful but is the explanation of spontaneous cure in certain cases.[1.] It is more likely to be effective if a course of graduated muscle exercises is followed, or, if the hernia develops after an illness when there is impaired muscle tone and convalescence brings improvement.

When a hernia has been present for more than a few days, even if it be small, impairment of efficiency of the inguinal sphincters follows and muscle weakness predisposes to further increase in size. The condition is progressive and ultimately the entire mechanism of the inguinal canal is thrown out of action. Muscle atrophy through disuse and direct pressure aggravates the condition.

Dilatation of the internal ring stretches the muscle sphincter and in a severe case it may be so enlarged that the inferior margin is in relation to Poupart's ligament.

Similar dilatation is seen at the external ring and the entire canal loses its valvular arrangement.

The cremaster becomes stretched over the distended cord and sac to appear as a thin sheet of fibro-muscular tissue blended with the surrounding fascial layers.

In the case of a direct hernia the overlying conjoined tendon is similarly affected and the inferior fibres atrophy to a thin fibro-muscular sheet devoid of tone and of little use either as a factor in repair or in support to the posterior wall.

CHANGES IN THE FASCIA.

The fascia transversalis is important to the support of the posterior canal wall, and this fascial layer together with the others of the area hypertrophies in the presence of

long standing scrotal herniae. It is not possible to say how long the hernia must have existed before the hypertrophy becomes marked, but it is, according to Oughterson[1.] likely to be five to ten years.

The hypertrophy is an adaptation of tissue to demands made upon it. The degree depends on the force required to restrain further development of the hernia, and that in turn is determined by the size of the abdominal ring, the intra abdominal pressure, the duration of the condition, the tonus of the muscles and whether or not a truss or support has been worn.

The cremaster fascia likewise hypertrophies at the expense of the muscle elements within it which are stretched by further enlargement of the rupture to form a thin fascial sheet. According to Oughterson[2.] the attachment of the cremaster fascia to Poupart's ligament is strengthened by this hypertrophy, and the process may be regarded as an effort to prevent further weakening of the floor of the canal and further dilatation of the spermatic cord.

This fascia has been used in a Gallie repair and may be sufficiently large to be plicated for further reinforcing of the posterior wall.

PATHOLOGY OF THE SAC.

The hernial sac may become thickened by what is commonly regarded as a chronic inflammation, particularly when the intestine or omentum has been a part of its contents or where a truss has been worn. Under these circumstances, adhesions between the sac and the contained omentum or intestine may be formed and irregular areas of obliteration of the sac have been described.[3] There may be such adhesion of the sac to the surrounding fascia and muscles that the whole seem to be infused into one fibrous structure.[4]

subjected 250 hernial sacs removed at operation to detailed histological examination.

They found that the peritoneum near the internal ring in infants at birth and also in adults consists of a single layer of endothelium resting on a delicate connective tissue with an intermingling of elastic fibres. They noted that often there is a mild degree of thickening of the supporting connective tissue at the point of the internal ring where it admits the cord, with a well defined pad of fatty tissue lying beneath the fibrous elements.

Study of the 250 sacs, both indirect and direct showed that they fell morphologically into two groups, a fibrous and a fibro fatty.

The first was a dense fibrous sub-endothelial layer supporting fine capillaries of arteries, veins and lymphatics

which course upward from a vascular and lymphatic plexus lying in contact with the deeper parts of this connective tissue zone. The subendothelial connective tissue in some areas has three layers, a superficial and a deep lying, parallel to each other, with a middle at right angles to the other two. Externally, the fibrous tissue layer lies in contact with structures such as muscle, fascia or the tissues of the cord. Elastic fibres are also found in the connective tissue zone directly below the endothelium.

These fibrous sacs tend to thicken further with development, and represent the more common form both in adult life and in childhood.

The second fibro fatty type is found more particularly in direct herniae. The subendothelial connective tissue layer is thin and delicate resting upon fatty tissue. The fat, externally lies on neighbouring muscle, fascia and structures of the cord. The fat may extensively invade and replace the subendothelial fibrous layer and has to be regarded as a process of atrophy.

Both types of sac are liable to inflammatory changes affecting chiefly the subendothelial layer of the connective tissue. This becomes swollen and infiltrated with inflammatory cells, usually lymphocytes, mononuclears, and eosinophils.

Areas of brown coloured pigment were also noted

suggesting old haemorrhage from trauma whilst recent haemorrhage was quite common. Hyaline changes have also been described by Choyce, going on even to calcification.

Out of the 250 sacs examined, 37 showed active inflammation and clinically these were almost all symptomless. This type of inflammation was entirely different from that associated with incarceration or strangulation. The authors considered it to be due to trauma. These may be followed later by adhesions.

In one case, parasites resembling trichinae were found in the subendothelial connective tissue zone.

The sac may contain a small quantity of serous fluid described then as a hydrocele of the hernial sac.

The adhesions which exist between the sac and its contents may be thin and filmy following upon recent inflammations or strangulation. In the chronic case, however, the adhesions may be firm, powerful and vascularised.

5.

MacLennan analysed a series of 1038 operations for hernia performed in the Royal Hospital for Sick Children between 1914 and 1920 with special reference to the sacs. Tuberculosis was present in five cases and vestigial relics in eighteen. In fourteen, adrenal cortical tissue was found on the outer side of the sac between the vessels of the cord and the vas. The cortical tissue resembled a tomato seed in appearance. The presence of such a remnant in a hernial sac

is considered by MacLennan to support the saccular theory of origin, as he believes it is detached from the main adrenal capsule during development of the processus vaginalis.

The significance of these changes in the sac is obscure. Only those due to inflammation are important, and there owing to formation of adhesions.

Tuberculosis of the sac is uncommon but recognised. Twenty-five per cent. of all cases occur in children under the age of five. During adult life, the numbers are minimal until fifty, after which the incidence increases.[6.] The lesion is always secondary to a primary infection of the peritoneum or intra peritoneal viscus. The fundus is chiefly affected and the lesion takes the form of scattered tubercles. These may proliferate to fill part of the lumen. A fibrocascous type is also recognised when nodules may develop and vary in size from a mustard seed to a walnut. The process may go on to pus formation. Adhesions are frequently associated and there may be direct extension to vas, epididymis and testicle.

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CHAPTER 12.

RATIONALE OF TREATMENT IN INGUINAL HERNIA.

CRITERIA OF OPERATION.

Before operation one must decide:-

1. Will the operation help the patient?
2. Will any complication, e.g. damage to testis be likely to follow in that particular case?
3. Is cure likely to be permanent?
4. Is the patient of suitable age?
5. Is the general condition of the patient satisfactory?
6. Is there any predisposing cause to the development of the hernia and thus liable to influence recurrence, which is capable of removal?
7. What will be the ideal anaesthetic for the particular case?

In regard to most of these points, the answer depends upon the choice of operation and the excellence of the surgeon. It may be stated that if there is no contra-indication in the shape of grave systemic disease, operation carefully selected and performed will benefit the majority of people with inguinal hernia and carry with it only slight risk of complication. The benefit of operation should not be withheld from any sufferer who is in reasonable general condition, and treatment should not be refused merely on the size of the rupture and with an eye to acquiring a lower

recurrence rate than one's colleague. Modern technique is capable of dealing mechanically with all but the most monstrous of herniae, and even they may be successfully cured. In age, operation can improve health, comfort and happiness by dispensing with the truss. In children it can be performed with safety and confidence.[4.]

S E C T I O N I.

IN INFANTS

Hernia in infants is always due to the presence of a congenital sac and it is sufficient to remove the sac through a small incision. This is conveniently done without opening up the external oblique aponeurosis for any distance, and the technique evolved in the Royal Hospital for Sick Children in Glasgow has found World Wide recognition and support.[4.]

Operation should not be undertaken until the child is thriving and seldom before the third month.

Cumston[2.] classifies herniae in infants as:

1. Complete Vaginal.
2. Funicular Vaginal.
3. Associated with Ectopic Testis.
4. Properitoneal.
5. Encysted Vaginal.

He advises in all cases complete extirpation of the sac through a small incision and condemns temporising with trusses. This view is also expressed by Grey Turner[3.] and by

MacLennan[4] who performed 1038 operations in the Sick Children's Hospital, Glasgow, between August 1914 and ~~December 1914 and~~ December 1920 with uniformly good results and only eight deaths.

Children under three years of age can be treated as out-patients.[5] Only a very small incision is required, and the only point in the operation which requires mention is the risk of traumatising the vas. The vas is here a most delicate structure and readily torn. If this accident occurs the ends must be approximated by a fine cat gut suture, which, if possible should be passed into the lumen of both ends. After removal of the sac, the pillars of the external ring should be approximated by one or two interrupted cat gut sutures.

No special after treatment is indicated.

There is a uniformity of surgical opinion that in infants and young children success follows treatment along these lines.

IN OLDER CHILDREN.

In children between the ages of three and sixteen years, the incision should be somewhat larger than that for infants, and the external oblique should be incised along the length of the canal to facilitate high excision of the sac. No form of plastic repair is required, and the patient is permitted to rise out of bed in two weeks. He is discouraged

from attempting strenuous exercise during a further month.

Here again there are few who advocate more elaborate procedures than this simple operation. Differences of opinion in regard to treatment do not arise save in the case of adult herniae.

SECTION II.

IN ADULTS.

Much controversy has existed, and still exists, as to how adult herniae should be treated, and most mature surgeons are firmly wedded to their own methods. The remainder of this chapter is devoted to a discussion of these methods and an attempt made to assess the excellence or otherwise of the surgical principles in common use.

In adults, treatment must be determined by the age of the patient, the size of the hernia, the duration of the condition, the sex, occupation, and general health. In general, it may be said that operation should be performed as soon as possible after appearance of the hernia.

Sex. In the female, the problem of cure is easier than in the male, and recurrences are fewer.

General Health. If the general health is good and no predisposing factor such as a chronic cough is present, there may be no indication for plastic repair, but, where the canal or rings are incompetent, some form of repair is indicated.

81.
Size of Hernia. Edmund Andrews has written that it is a disgrace that simple herniotomy can not be done in 100% of cases. There is an adequate guarantee against recurrence in these cases where the canal is intact and the only abnormality, the presence of a sac. He says that the common need for repair is a reflection on the intelligence of the doctors who "fool about with trusses", and upon the intelligence of the patient who ignores his early swelling, leaving it till too late for conservative treatment.

Type of Operation. The modern conception of the majority of sacs being congenital in origin is a cogent argument for early operation.

No matter what type of repair is adopted, recurrences
82.
are found, and, according to Foldes, it is better to be able to do one repair well than to do the best method incorrectly. This is an unsound dictum. It is up to the practising surgeon to acquaint himself with the best method and to make himself efficient in its use. If he can make himself efficient with one technique, it is up to him to let that be the best, otherwise he had better not continue his craft. In any case, it is not sufficient to be able to perform one operation well because the problems presented by different cases may require different operative procedures for their conquest. In that fact lies a part of the explanation for the very many modifications which have been suggested to the

Bassini, or Halsted operations by various surgeons. One other reason for the development of these modifications lies in the high recurrence rate associated with the Bassini operation. Unfortunately few, if any, of the suggested modifications have been more successful than the original 83. except perhaps in the hands of their designers and this is not sufficient. For any operation to be regarded a success it must be capable of giving good results in the hands of any competent worker.

For all practical purposes the Bassini, Halsted and MacEwan operations with all their modifications are fundamentally similar. They have in common high ligation of the sac, transposing of the cord, and a plastic repair designed to strengthen the posterior wall of the inguinal canal. This plastic repair is union of a muscle and that generally the conjoined tendon, to Poupart's ligament.

In any clinic where it is the custom to perform this type of repair, over a large series of cases not only will the classical Bassini be performed but also many modifications to fit the various requirements of different cases. Thus in published figures the statistics are those of the clinic 'Using the Bassini operation or one of its modifications'. Occasionally, the Classical Bassini is specially mentioned, at others the Halsted, Andrews, or one of the many others, but they can conveniently be considered for the purposes of

discussion as modifications of Bassini. To avoid use of this clumsy phrase, the term "Bassini" will be used throughout this thesis to indicate any modification of the Bassini operation. The expression Classical Bassini will be used where that operation has actually been put into practice.

THE BASSINI OPERATION AND ITS MODIFICATIONS.

84.

In a paper published by Randall, Deaver, Professor of Surgery, University of Pennsylvania, Harvey, Chief Surgeon in New Haven (Connecticut) Hospital; McGuire, Professor of Surgery, Vanderbilt University, Nashville, Tennessee; Phemster, Professor of Surgery, University of Chicago; White, Surgeon to Washington University, Washington, D.C.; and Morgan of Tahon Springs, Florida, all condemn the hernia operations of Bassini and his successors in private letters to Randall quoted in his article, and admit to a minimal 25% recurrence rate on the average.

On the other hand, a great deal of confidence is reposed in the Bassini operation by many workers, 85, 6. and some even claim 2 or 3 per cent. recurrences with it. A great gulf separates the two extremes of opinion!

There can be no doubt that the Bassini should not be applied to all cases, even by its most ardent exponents.

Effect on the Muscles.

Edwards[83.] operated on 53 recurrences after the Bassini operation and found that the internal oblique was then but a thin sheet of attenuated muscle, pale brown in colour. In his view, it was unlikely that it could exercise any control over the internal ring. He concluded that in general, operation results in a weakening of the normal mechanism of the canal. In 19 cases of recurrence, in which ligature and excision of the sac only had been performed, the muscles were comparatively unscathed.

Multiplicity of Modifications.

One of the most damaging pieces of evidence which can be lead against the Bassini operation is the fact that so many surgeons have adopted their own modifications. The reason for this surely must be that the results of the Bassini operation in their hands were unsatisfactory. Unfortunately, none of the modified operations give uniformly better results than the original.[3.]

In a very extensive survey of the literature over seventy modifications of the original Bassini have been found by myself. Many of these are almost identical and have been claimed as original by designers unaware that others at an earlier date had tried the method and found it wanting. No useful purpose is gained by listing these many suggestions, but it may be said that they have concerned each

and every possible anatomical structure in the region of the inguinal canal, and altered each structure in ways as ingenious as they are numerous.

But most of the modifications have one common factor, an attempt at union between the conjoined tendon and Poupart's ligament. It is reasonable to believe that in that step may lie the reason for the indifferent results found by so many people.

It is pertinent to enquire as to the rationale of doing this step in the repair of inguinal hernia at all.

Indications for reinforcing the posterior canal wall.

In a small or moderate sized indirect hernia where the muscles are undamaged by distension and where the rings are sound, the posterior wall of the canal is generally found at operation to be sufficiently strong to fulfil its functions of support. Why should any endeavour be made to strengthen it? In those cases where the sac is of the congenital type, or where the history leads one to believe the condition is congenital, if the muscles are sound there is no need to strengthen them. Nature is better at guarding anatomical danger spots than Man. In any case, 75% of the recurrences after Bassini operations take place at the internal ring, the spot, or one of them which the operation has been designed to protect.

3.

In many cases the precipitating cause of the hernia

was probably in some unexpected strain imposed on the internal ring taking the sphincter unawares. If the congenital sac is removed in these cases, any tear of the fascia transversalis repaired, and the lateral pillars of the internal ring sutured to narrow the opening, the probability is that a good result will be obtained.

Support requires to be given to the posterior wall in all cases of direct herniae, in those where the muscles are weak and stretching of the canal has followed. But in these circumstances the conjoined tendon is generally also atrophied to a greater or less degree, and unsuitable as a medium for support to the weakened area.

Moreover it may not insert into the pubis but show an abnormal insertion into the rectus mouth some distance above the pubis. This type of abnormality has been discussed by Polya, Bloodgood, Skillern and Foules, and is more frequent than is commonly accepted.

Thus even where there is an indication for strengthening the posterior wall, the Bassini operation is unlikely to give a satisfactory result owing to the poor material at hand for use in repair.

Where the posterior wall is adequately powerful, further support to it by a Bassini operation does not give the necessary added support to the internal ring or area lateral to the pubis, which are the fundamental weak spots

and sites of the majority of recurrences.

Stein[7.] states that suture of the conjoined tendon to Poupart's ligament is wrong also because of the fact that nowhere in human economy is muscle used as a buffer state, as its functions are motion, locomotion and stabilisation.

Site of Recurrence. Three quarters of the recurrences of Edwards'[3.] series took place through the internal ring, the site least guarded by the Bassini repair, so the operation gives little support to a site where recurrence is liable to develop.

The most common sites of recurrence are

(1) The internal ring.
(2) Immediately lateral to the pubis.
(3) Through the posterior canal wall. 91.

Of these three only the last is adequately protected by the Bassini operation. If the conjoined tendon is atrophied or abnormal in its insertion the medial part of the canal cannot be effectively guarded as it is not possible to bring down the medial limit of the tendon to Poupart's ligament.

Recurrence Rate for the Bassini Operation. Study of recurrence statistics is interesting but confusing owing to the wide variations in results of different clinics over the world. This applies to statistics regarding any type of hernia repair. Very many variable and uncontrollable factors influence the statistical analysis. First, the question as to what constitutes a recurrence. To a critical eye, a

small bulge may be accepted as a failure, whilst a larger one may be considered as being within normal limits by another.[9.] Many cases which recur do not return to the same clinic for further treatment, and, in the absence of an efficient follow up system, the recurrence figures for the Clinic may be gratifyingly low. Certain people state that this being so, any given clinic has its quota of recurrences arising from other places, and that these migrant recurrents cancel each other out from a statistical point of view. This is a beautiful thought but not sound deduction.

The question as to length of time after operation before re-examination is important.[84.] Randell takes the view that success can be based only upon the results of a five year period or over. This is not the general opinion, and Joyce,[10.] Taylor,[11.] Patterson,[12.] Fallis,[13.] Edwards,[3.] Gould,[14.] and others consider that the vast majority, up to 80% recur within the first year, while many consider that the majority recur within the first six months. This is the opinion of Coley.[15.]

My own view is that the recurrence rate rises slowly with every year after operation, but that for practical purposes the majority of recurrences take place within the first year. In my own series most recurred within six months.

Many follow up statistics are based upon a written questionnaire sent to the patient and returned with his own

findings. This is a method liable to give a low recurrence rate as a substantial number of people are unaware that they have a recurrence.

. Nevertheless, bearing the many variable factors in mind, there are published figures which appear to be as accurate as is possible and for the Bassini operation and its modifications the following table illustrates representative figures taken from many different clinics. The figures are for oblique inguinals.

T A B L E I.

Recurrence statistics for Indirect Inguinal Herniae treated by a Bassini Operation.

Surgeon	Operation	Number	Recurrence
Fallis[13]	Halsted	1386	8.6%
Fallis[13]	Bassini	214	13.4%
Oedenarde[16]	Bassini	French Navy	10%
Goldner[89]	Bassini	466	8%
Coley[15]	Classical Bassini	332	8.7%
Massachussets General Hospital[17]	Bassini		9%
Druner[90]	Bassini		21.4%
Bellevue, N.Y.[17]	Bassini		7.5%
John Hopkins, Boston.[17]	Bassini		10.9%
Max Page[18]	Bassini	London Police	20.2%
Selinger[19]	Classical Bassini	266	18.0%
Erdman[20]	Bassini	1093	6.67%
Taylor[11]	Bassini	816	5.6%
Schwartz[88]	Bassini	207	6%
Average Recurrence			11.8%

This figure is based on follow up of all the cases and is an average culled from several sources which corresponds closely to the general experience of recurrences for indirect herniae in the adult male treated by the Bassini Operation, Classical or Modified.

The technique of a Bassini is more likely in theory to afford support to the canal which is the site of a direct hernia. Table II gives analysis of results with direct hernia from various clinics, and based upon adequate follow up of cases.

T A B L E II.

Recurrence statistics for Direct Inguinal Hernia treated by the Bassini operation.

Clinic or Author	Number of Cases	Recurrence
Erdman[20]		16.1%
Massachussets General Hospital 17		15%
John Hopkins Hospital[17]		29.1%
Taylor[11]	77	22%
Watson[21]		20%
Lyle	75	13%
Fallis[13]	154	11.6%
Lameris	102	28.4%
Bruenor	171	18%
Taylor	256	18%
Coley[15]	280	5%
Max Page	London Police	25.8%
Gibson and Felter[22]	427	6.5%
Average recurrence		17.6%

In all the literature, the figures of Gibson and Felter[7.] with those of Coley[15.] are remarkable for being so much better than those of other workers. The explanation for this is hard to seek, as it is improbable that they are technically superior to many others amongst their gifted colleagues.

Frank[23.] found that in 7000 direct herniae operated on in the Mayo Clinic the recurrence rate was just under 1% when the cord had been transplanted by some form of Bassini operation. Frank goes on to say that the prospect of cure can be "promised the patient absolutely". This I do not believe, and moreover do not believe that the Mayo true recurrence is as quoted. Frank does not state either criteria of recurrence, period of follow up or whether the cases were followed up at all. His paper is representative of that type which is sometimes found in the literature and is wide open to criticism on the grounds that opinions unless backed by observation; controlled facts and scrupulous accuracy are valueless.

There is no suggestion being made in the cases of Gibson or Felter, that their cases are deliberately selected, and, according to themselves they conduct a thorough follow up examination at least one year after operation. Still the results they submit for direct herniae are superior to those of other workers, and one feels that there is some reason for

it which has so far not been made clear. If their results are due to the excellence of their technique they have much wherein to congratulate themselves.

Coley has indicated that cases should be selected with a view to achieving good results and therein lies a clue to the success he claims in his series.

From an impartial consideration of results from many reputable sources, it is shown that the Bassini operation carries with it a recurrence rate on the average of 11.8% for indirect inguinal herniae and 17.6% for direct. These figures are too high to be satisfactory.

The Union of Conjoined Tendon to Poupart's ligament.

It has been mentioned that the Bassini operations have all one step in common, union of muscle, usually the conjoined tendon, with the inguinal ligament. Therein may lie the source of failure and extensive investigations have been conducted into the rationale of this step in the technique. Controversy has raged round the question as to whether or not satisfactory union can be achieved by attempting to unite muscle with tendon. The subject must be approached both from the clinical and from the experimental points of view.

It should be noted that the structure described as "conjoined tendon" is tendinous only near its insertion and that in the main it is composed of muscle fibres. It

extends from the internal ring medially to the pubic tubercle.

Clinically, Edwards[3.] noted at operation on 53 recurrences after Bassinis that the internal oblique in most cases was a thin attenuated sheet of pale brown muscle, and considered it was unlikely that it could afford much protection to the internal ring, or to the posterior wall. The findings after recurrences for simple herniotomy showed healthy muscles. He concluded, therefore, that the Bassini sutures lead to muscle atrophy and results in a weakening of the canal. The evidence of Max Page[18.] supports Edwards' opinion. Page contrasted his figures of 1934 with a 20.5% recurrence rate after Bassini repairs, with those for 1943 when he had improved his results to 12% failures as a result of adopting more conservative methods of treatment, and using herniotomy rather than hernioplasty in those early cases where muscles were sound. Moreover, in his series, there was no selection of cases, and the results are a fair comparison showing improvement only because of the new method used in treatment.

Turner and Eckhoff[44.] give a recurrence rate of 3% for 98 simple herniotomies. These compare very favourably indeed with the figures for the Bassini listed on Tables I and II.

Opinions concerning the Bassini results show a general feeling of dissatisfaction amongst all students of the subject

save one, Coley, and he in his yearly reviews in Progressive Medicine[24.] has shown a decided feeling of satisfaction with the Bassini operation.

According to available evidence the method does not give uniformly good results. Whilst some find it satisfactory many very competent surgeons condemn it.

At operation, one frequently has observed a tight Bassini suture cut through the muscles and that whilst they are in a state of relaxation under anaesthesia. How much more likely is this to occur when the patient wakens from his anaesthetic, coughing or straining with post operative sickness? But it is not sufficient to blame the union of muscle to tendon for the high incidence of failures unless experimental and pathological evidence confirms this.

Seelig and Chouke[25.] attacked the problem experimentally, and found when they sutured a flap of fascia lata in a dog to the underlying muscles that the sutures were liable to cut out. Even where they did not cut out, union took place only by means of thin scar tissue which was easily stretched.

Burdick[26.] found that suturing fascia to muscle lead to healing by means of delicate scar tissue which developed from the areolar membrane investing the surfaces, and from the loose connective tissue stroma separating the bundles of fibres. He stated that the scar is not strong, and if subjected to strain slowly stretches. Where linen or silk

was used instead of catgut, the tendency to stretch was not so marked, but frequently the linen cut out and gave the same result as when cat gut had been used. Scarification of the tissues before stitching increased the density and strength of the scar, but prolonged and unusual strain still resulted in its yielding. Side to side suturing, as when conjoined tendon is applied to Poupart's ligament never resulted in permanent adhesions, but yielded after slight strain.

Lee MacGregor[27] has stated that in his opinion, muscle will not act efficiently when sutured so as to alter the direction of its normal line of fibres. Fibrous degeneration he says, follows at an early date. He also believes that firm union is possible only when fascia is stitched to fascia or muscle to muscle, but not when muscle is stitched to fascia.

Koontz[28] further investigated the problem but failed to verify Seelig and Choukes findings in their entirety. He showed in one series of experiments, that muscle did unite to fascia, but only when the areolar tissue had been thoroughly removed before suturing. The strength of the resulting scar depended on the intimacy of contact between the two structures. If this union was not sufficiently close, stretching took place at a later date.

Rosenblatt and Meyers[2] also succeeded in promoting

union between muscle and fascia, verifying the work of Koontz, but suggested that the main factor in effecting it is tight tying of the sutures. This, they said, induces a fibrin reaction which is later transformed into connective tissue.

A further contribution by Rosenblatt and Cooksey[3.] described the findings in 21 operations on dogs wherein the internal oblique or rectus muscle was sutured to the inguinal ligament with silk gut. It was found 40, 60 and 70 days later that there was firm union between the muscle and fascia in all cases. The union did depend, however, on complete removal of all areolar tissue, and the strength of the scar also had a relation to the area of the surfaces in contact.

They stated that to permit the areolar tissue to remain is to invite the situation which exists in a joint, that is, non-adherence of insulated structures. The union takes place when, by removal of all this areolar tissue, there is intimate contact between the muscle bundles and the adjacent fascia or tendon. The muscle bundles are surrounded by a sheath of white fibrous connective tissue, and each muscle fibre has its neighbour bound to it by the same element. The entire muscle or group of bundles is also held together by white fibrous tissue. The elements for a connective tissue union therefore, are present and explain how union does take place. The muscle is united to the fascia or tendon by scar tissue. There is no conversion of

muscle cell to fascia.

Roberts[31] agreed with Seelig and Cooksey and stated that it is rarely possible to achieve sound union between elements which are of different structure.[86] He, with Cowie stated that as Poupart's ligament is of white fibrous tissue, and conjoined tendon is of red muscle, union by firm scar tissue cannot take place.

Fairfield[32] has made yet one more pertinent observation, namely that fascia does not even unite with fascia 'WHEN OVERLAPPED' except when sufficient trauma has been inflicted upon it to promote fibrous union. The tendency of overlapped fascia is to resist union, and to slide continuously the one flap upon the other fascial flap, 'as they were originally intended to'. This gliding function of fascia does exist, but Fairfield's findings are not backed by other observations, and in fact, as witnessed by results of many hernioplasties, are not accurate. Fascia does unite with fascia even when overlapped, and in Gould's, and in the Gallie method of repair, fascial strips do overlap, and with excellent end results.

The experimental findings therefore, are somewhat conflicting but the concensus of opinion is that union does take place only under very definite conditions, and these demand that all areolar tissue is removed from the areas to be united, and that the sutures are applied under tension.

On the practical side further evidence comes from the operating theatre. It is recognised that in many cases of repair, Bassini sutures are applied to tissues which are reasonably well developed and that apparently a firm reinforcement of the posterior wall will be effected. Yet, when operating on the same cases again for recurrence, the lower part of the conjoined tendon is found to be atrophied and recurrence has developed just lateral to the pubis. This can only be considered as a pressure atrophy due to necrosis at the site of the tight sutures. This observation has been made in the literature by several writers and occurred in my own experience.[32, 33, 34.]

It may be stated after consideration of the practical and experimental evidence that in this step common to all Bassini operations there may be one reason for their comparative failure. Other factors also may be at work. These remain to be discussed.

Does the Bassini Operation protect the sites of Recurrence?

What is the intention of a hernia repair where there is muscle weakness? It is to give protection to the entire length of the posterior wall of the canal, and to strengthen and narrow the internal abdominal ring after the offending sac has been removed at a high level. The Bassini operation does not do these things. Two weak spots, or potentially weak spots remain after such a repair, one is immediately

lateral to the pubis, at the extreme medial end of the canal,[33, 34, 35] and the other is at the internal ring.

The conjoined tendon may be thin or atrophied, and insert into the lateral border of the rectus instead of into the pubis. It is in this medial portion of the posterior wall that recurrence may develop after hernioplasty for the indirect type. There is thus a weak area, triangular in shape, and bounded medially by the lateral border of the rectus for a varying distance, inferiorly by the margin of Poupart's ligament, and superiorly by the lower margin of conjoined tendon.[36.] The floor is formed by fascia transversalis. One object in performing a plastic repair is to obliterate this triangle. The Bassini operation fails to do this effectively, and especially is this so when the conjoined tendon has an abnormal insertion.

The internal ring can be narrowed by carefully applied sutures but these are applied to the fascia transversalis rather than to the internal oblique, and this step in the operation is frequently missed through excessive enthusiasm for the 'conjoined tendon-Poupart sutures'.

<u>The Bassini Operation and the small indirect hernia</u>.

There still is one other factor which may help to explain the failure of the Bassini. Its application to cases which do not require plastic repair at all.

It cannot be over emphasised that if the muscles and

rings are competent, there can be no indication for plastic repair of any kind. Removal of the sac is sufficient in 87.
these cases, and untimely performance of Bassini repairs is not only useless but actively harmful, predisposing to recurrence by causing atrophy of the lower fibres of the conjoined tendon.

Reasons for failure of the Bassini Operations.

The Bassini operation may fail:

1. Because it is applied to cases not requiring plastic repair.
2. Because when used, as for example in direct herniae, the conjoined tendon may be so atrophied that it is of but little value as a means of support.
3. Where it is used as a consequence of wrong judgment and with a normal musculature, it predisposes to recurrence through causing pressure necrosis and atrophy of the lower fibres of conjoined tendon.
4. Because even when used in cases worthy of repair it still fails to guard the medial portion of the posterior wall of the canal, and may also not guard the internal ring.
5. Because frequently the conjoined tendon is sutured to Poupart before all the areolar tissue over the parts has been removed with meticulous care, thus achieving poor union and finally -
6. Because the sutures have been tied too slackly.

It follows from discussion of the available facts, that the Bassini Operation is found wanting from points of view of end results, rationale, and technique. When applied to an unsuitable case it is actively harmful and prejudicial to late success.

In view of these considerations, some alternative method must be adopted for those cases requiring plastic repair, and before it can be claimed superior to the Bassini,

must from every point of view be demonstrated to be more sound, both in rationale and in late results.

THE USE OF FASCIAL SUTURES.

McArthur[37] in 1901 introduced the use of living fascial sutures for repair, but, since that time the method has not been so extensively accepted as it deserves, and comparatively few surgeons have adopted it as a routine measure. McArthur utilised strips cut from the aponeurosis of the external oblique muscle, and applied them following the principles of Halsted or Bassini.

In 1910, Kirschner[38] developed the technique and chose strips of fascia or a plaque of fascia lata cut from the thigh. Since then, the only outstanding contribution has been made by Gallie and Le Mesurier[39] who further advanced Kirschner's method and published their work in 1921.

Wangenstein[40] suggested using the ilio-tibial track as a pedicle graft, but this does not seem to be necessary.

Gallie and Le Mesurier threaded strips of fascia lata through special needles and interwove them between the conjoined tendon and Poupart's ligament. They showed that the fascia excited no inflammatory reaction, that it survived for many years, united with the tissue in which it was embedded, and, owing to its great tensile strength did not stretch as does ordinary scar tissue. The use of the

special needle folded the fascia into rounded cords which, in the course of a few weeks became surrounded by a film of vascular areolar tissue. From this film, septae of similar tissue penetrated the spaces between the folds and into the adjacent structures, to effect firm union, and form a dense plaque of firm fibrous tissue.

At the end of three weeks any individual fibrous strand had the appearance on section of a structure closely resembling that of normal tendon.

In 1940, McLoskey and Lehman[41.] and also Joyce[42.] attempted to stimulate further interest in the use of fascia, and emphasised that it should not be reserved exclusively for very large and very difficult herniae, but for all where plastic repair was indicated. Edwards[3.] also recommends it for any case requiring repair, and in the last few years it has become much more extensively used.

Histology of Fascial sutures.

Burdick[26.] has stated that free transplants of fascia lata placed so as to receive an adequate vascular and lymph supply continue to live unchanged, but, when used to fill an anatomical defect, heal to the structures to which they are sutured. The degree of adhesion depends upon the extent to which the fibrous tissue has been cleared of areolar tissue. In order to overcome the element of chance which attends the growth of this type of union, fascia used as living sutures

has been found to give much more powerful results and more satisfactory union. Gallie and Le Mesurier demonstrated that such sutures continue to live practically unchanged and retain their tensile strength. They maintain the approximation of the tissues they are designed to apose and effect union microscopically with the fibrous elements in the muscle.

Dean Lewis[43] further verified that fascia used thus to fill tissue defects did so without losing its gross anatomical and histological characteristics, and that union to adjacent structures is effected by a process of aseptic inflammation advancing to formation of spindle cells and fibrous tissue with blood vessels forming across the line of suture. One year after implantation there is no further change in the transplanted fascia.

This initial reaction may at times be excessive, and if operation is carried out a few weeks after the initial fascial repair the fascia is found embedded in a mass of fibrous tissue so firmly as to defy clean dissection. Operation on cases at a later date proves that this excessive reaction undergoes so much absorption, that the individual fascial strands although welded together can still be clearly defined.[14]

<u>The use of "Dead" Fascial sutures</u>. The practical use of fascia as living sutures has been found to have certain

disadvantages. In order to overcome certain of these, attempts have been made by various workers to use dead fascia suitably sterilised and preserved. The work performed in this regard is of importance in throwing light upon the histology of fascia and connective tissue generally.

In 1916, Nageotte evolved a theory of the origin of connective tissue which subsequently formed the basis of his experimental work.[45.] For many years there have been in existence two theories of the origin of connective tissues. The "exoplasm", claiming that they are formed from transformed portions of protoplasm, the exoplasm, which comes from a syncitium of mesenchymal cells; and the "cellular secretion" theory which suggests that the early syncytium of the mesenchymal cells secretes an amorphous gelatinous non-living ground substance in which the connective tissue fibres develop and form.

Nageotte believed that albuminoid coagula are first formed from the parenchymal cells and that these coagula are no more living than the coral of polyps; that the problem of origin is the same as that of the formation of blood plasma. This fundamental substance (substance fondamentale) is not amorphous, but composed entirely of elementary collagen fibrils which give rise to collagen fibres, and that connective tissue is formed by the penetration of fibroblasts into the meshes of the fibres. Nageotte insisted on

the fundamental non living character of all the connective tissue substances.

Baitsell, quoted by Koontz[46.] also investigated the problem. He observed the direct transformation of fibrin clot into connective tissue fibres. Tissue cells migrated into the clot. They did not digest the fibres, but, by their movement, caused the bundles to be divided into smaller ones. These tissue cells were rounded when they first appeared, but later assumed the typical form of fibroblasts. Baitsell could find no evidence that these cells formed new fibres. After further work along the same lines he showed that the transformation of fibrin clot into connective tissue was brought about by a fusion and consolidation of the fine elements of which it was composed.

Nageotte described the transformation of dead enclosed cartilage cells into collagen substance, and, in 1920[46.] described a similar metamorphosis of fibrin clot, verifying the work of Baitsell. Nageotte considered that if connective tissue substances are inert coagula formed from living cells, one would not expect grafts of dead tissues to act as foreign bodies and induce phagocytosis. He considered that the response of the body to 'dead' fibres of fascia should be the same as to living ones. The results of his experiments tend to support such a premise.

Nageotte transplanted pieces of tendon killed by

alcohol or formalin and found that these attached themselves promptly to the connective tissues which received them. The dead graft became adherent to the living tissues, and in a few weeks it was not possible to determine its limits because union between the dead and the living tissues had approached perfection. Microscopic examination showed no line of union or demarcation between the two. Union was effected by phagocytosis of the dead protoplasm, followed by immigration of young fibroblasts into the persisting connective tissue framework of the graft, these cells establishing themselves in place of the former inhabitants. Young blood vessels rose from the host and vascularised the graft thoroughly. This sequence of events was called 'reviviscence of the graft'. Jalifier[47.] and Christophe[48.] implanted dead tendons, and even an entire patella with its quadriceps and patellar tendons that had been preserved in 80% alcohol for three days into the knee of a soldier who had lost his patella from a gunshot wound four months before. The functional result of this and other similar experiments was excellent. In the case of the grafted patella, radiographic examination four years later showed a normal appearance of the affected knee joint.

On the basis of the theories and experiments outlined above, Koontz[46.] was stimulated in an attempt to use dead fascial grafts for the repair of tissue defects, and

especially for hernia, the object being to obviate certain difficulties attendant upon the use of living fascial grafts. He performed twenty operations in dogs and cats, using fascia preserved in 70% alcohol from three to seventy days. Fascia lata and the rectus sheath were the sources of the grafts. The results were satisfactory in all cases. The graft remained in place, attached itself to the surroundings and became revascularised. After further work Koontz found that the fascia lata of the ox was the most satisfactory substance for this purpose, and since performing these experiments, the technique has been applied to the human subject by several American workers, including Coley.[29].

Rosenblatt and Meyers verified the work of Koontz and declared that union between the dead graft and the living tissues was effected by:

1. Ingrowth of fibroblasts from the host to the graft.
2. By phagocytosis of the dead protoplasm in the graft.
3. By the development of a vascular network between the host and the graft.

These workers further observed that if the fascia was sutured under tension union was even more powerful.

Finally, they determined that ox fascia preserved in 70% alcohol gave better results in repairing anatomical defects than when autogenous fascia was used.

On the basis of work by these many workers upon the use of both living and dead fascial grafts for repair of

anatomical defects the rationale of the procedure can hardly be doubted. Nor can it be argued that the rationale of methods suggested, whether by dead or by living fascia, are inferior to the method of suturing ligament to red muscle.

Recurrence Rate. The question of clinical results must now be considered, where the use of fascia has been applied extensively in the operating theatres for hernia repair.

Difficulty in assessing the value of published figures has previously been indicated. A typical example of arriving at inaccurate conclusions is provided by an article by O'Connor[6] of Ireland. He states that in ten years he did 103 operations for hernia. The fascial method was used twice and is condemned as being time consuming and unnecessary. Conclusions should not be based on such limited experience.

TABLE III.

Recurrence rate for Indirect Inguinal Herniae repaired by Fascial Sutures.

Surgeon or Clinic	Operation	Number	Recurrence	Follow up
Grey, Stobhill, Glasgow.[49]	McArthur	54	7.4%	3 yrs.
Foster[50]	Gallie	101	7%	1.5 yrs.
Lyle[51]	McArthur	100	3%	1 yr.
Cattell-Anderson[41]	McArthur	123	4.6%	1 yr.
Gould[14]	Gallie	87	9.2%	1 yr.
Andrews[81]	McArthur	43	9.3%	1 yr.
Average recurrence rate for indirect herniae - 6.75%				

TABLE IV

Recurrence rate for Direct Inguinal Herniae repaired by Fascial Sutures.

Surgeon	Operation	Number	Recurrence
Robins 41.	McArthur.	27	0%
Lyle 51.	McArthur.	54	9.5%
Cattell-Anderson 41.	McArthur.	51	7.8%
Cattell-Anderson 92.	Gallie	-	11.7%
Average recurrence rate for direct herniae - 5.6%			

The figures quoted on Tables III and IV are, so far as can be determined from consideration of the papers from which they are quoted, entirely reliable. They are based upon adequate follow up examination, and from clinics in several parts of the world.

On the basis of results from fascia these representative figures are comparable with those found in most centres, and are more satisfactory than the results claimed by the Bassini operations. Before being able to claim that fascia as a method of repair is superior to that of the Bassini operation it is necessary to study the sequelae of operation and compare the immediate and late morbidity statistics.

MORBIDITY AFTER HERNIOPLASTY.

By the term "Morbidity after Hernioplasty" is meant the abnormal or diseased conditions incident to hernioplasty, in contradictinction to mortality. In formulating morbidity statistics the following factors are important:

1. The mental attitude of examiner, critical or indulgent.
2. Mental attitude of patient, whether complaining or otherwise.
3. Exact findings recorded on the spot by careful clinical examination at varying intervals after operation.

52.
MacKechnie analysed a large series of cases operated on by various surgeons in America and found that pain in the scar was the most common late complication. This was considered to be due to catching of the ilio hypogastric nerve in a deep suture or in scar tissue. The pain can be either sharp or dull, continuous or intermittent. MacKechnie found the sequence of events to be paraesthesia, anaesthesia and hyperaesthesia in that order.

A second type of pain was considered to be due to stretching of the scar and this is normally due to aching with occasional sharp exacerbations.

The second most common group of conditions were those due to undue narrowing of either internal or external ring. Slight pressure causes varicocele; further increase in pressure on the vessels of cord causes ischaemic atrophy of the testicle. Inclusion of the vas in a suture leads to

cystic dilatation of epididymis and vas with possible later pressure atrophy of the testicle.

After herniotomy the testicle on the affected side may temporarily be suspended at a higher level than usual. The organ gradually gravitates to its normal suspension level within a few months.[53.]

TABLE V.

COMPARISON OF MORBIDITY AFTER OPERATIONS BY BASSINI AND FASCIA METHODS.

Complication or Sequel	Immediate								Remote						
	Bassini					Fascia			Bassini			Fascia			
Reference Number	95	93	12 94	54	22	20	51	13	56	55 20	22	12	51	13	50
Phlebitis						9%									
Scrotal Haematoma		7%			3.1%	9%		.8%							
Scrotal Hydrocele						4.4%			13.4%	3%	4%	3.8%			
Post operative pneumonia			3%	4%	1.8%			2.7%							
Post operative sepsis	3.8	10.5%	0% 7%	5%	3.7%	4.8%	1%	1%		.6%					.10%
Post operative orchitis			5%		1.1%	8.1%									
Testicular atrophy										3%				.25%	
Varicocele										6%	1.2%			.2%	
Recurrence										9%			3%		7%
Mortality		.53%								2%					
Thick cord upper scrotum										15%					
Post operative sepsis of thigh							3.1%								
Embolism or infarct					.4%										
Post operative bronchitis		9.2%			1.7%										

A number of papers are available in which there is a full discussion of morbidity after hernioplasty following the Bassini technique, fewer have been found giving satisfactory figures for fascia, but Table V shows that there is a definite liability to post operative hydrocele after a Bassini, while this has not been noted concerning fascia. Erdmann[55.] found that when the pampinniform plexus is excised at operation for hernia the post operative incidence of hydrocele is 20%, while it is only 3% if the plexus of veins is left intact. In a series of sixty consecutive hydroceles dealt with by the same author, 21% of the series had been subjected to previous herniotomy. There is apparently an association between the two conditions. Hydrocele is less frequent in operations performed for direct hernia than for indirects.

Of these cases of late post operative sepsis reported by Taylor and Erdman, the condition was blamed on the use of buried linen sutures.

On the whole, there appears to be a somewhat higher incidence of post operative complications after the Bassini operation than with fascia, but fascia has one or two other disadvantages which are not associated with the Bassini. A number of cases suffer from post operative pain or discomfort in the thigh at the site from which fascia has been removed.[1.] This may be a disability of significance and is

mentioned by Edwards[3] in regard to its presence in Service Cases. It is also important where there is any suit for compensation impending. In my own series of 123 fascial repairs 25 % suffered from late pain in thigh. In addition to this pain there may be, where a large fascial graft has been removed, a resultant muscle hernia. A patient takes a poor view of this type of swelling and feels that he has but exchanged one lump for another. The figures for post operative chest complications seem to be more favourable than is actually the case.

Lucas[57] investigated the post operative pulmonary conditions of large numbers of Service men who had had a fascial repair performed. He found the following results in several series of cases:

TABLE VI.

Series	Anaesthetic	Number of cases	% severe chests	% moderate	% slight
1.	N_2O, O_2. Ether	85	14.1%	16.5%	30.5%
2.	Pentothal. N_2O, O_2	69	8.1%	8.1%	33.5%
3.	Local Anaesthesia	68	11.8%	10.2%	22%
4.	30 grains Chloral Hydrate plus Local Anaesthesia	46	10.9%	2.9%	30.8%

This series of figures seems high, but, when Lucas says 'slight chests' he implies a case with slight clinical signs,

slight cough and temperature not above 100.0 clearing within three days. The 'moderate' type is where it lasts for over five. In the discussion which followed his paper, other anaesthetists agreed with his findings. There is a higher incidence of chest complications when fascia is used.

Viewing the conflict of thought between the exponents of the two types of operation, Bassini or Fascia, evidence suggests that Fascia is superior.

My own figures for a series of cases dealt with by the two methods are discussed in a later Chapter.

OTHER METHODS OF TREATMENT.

Certain other methods of treatment remain for consideration.

THE TRUSS.

In Finsbury Square, London, there is a Truss Society, a Charitable Institution which gives away several thousands of trusses per annum, and has dispensed over three quarters of a million during the past century. In the ten year period, 1917-1926, it dealt with 365 recurrent cases operated on by senior London surgeons. 58. It has already been noted, page 9 that in the Wellcome Historical Museum there is an illustration of an Egyptian Mummy wearing a truss, indicating that not only is hernia an ancient disability, but that the wearing of a support is one of the oldest methods of treatment.

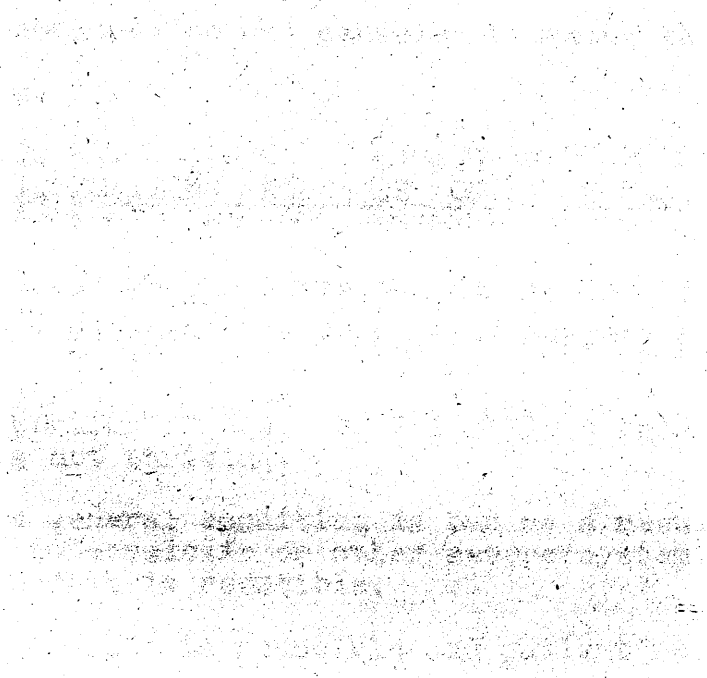

Figure 27.

Illustration of well fitting truss.

Very many people are walking about with their hernias supported by a truss, and apparently entirely satisfied with the support given. It is equally true that an ill-fitting truss is an abomination and capable of making the patient's life a misery.

INDICATIONS FOR USE OF A TRUSS.

1. In very obese people where the hernia is reducible, a truss is indicated[59]. as results of surgery are apt to be poor.
2. In a proportion of cases of infantile hernia where the infant is not thriving.
3. Where the general condition is bad as a result of heart disease, tuberculosis or other severe systemic condition and the hernia is reducible.
4. Where the hernia is reducible and patient refuses operation.
[96].
5. Peterson has advised it for ALL children under 5 but that is not a general view.

CONTRA-INDICATIONS.

1. All cases where the hernia is irreducible.
2. All cases where the patient is in good health, and there is reason to believe that surgery should cure the condition.
3. All cases of hydrocele in the male and cyst of the spermatic cord or canal of Nuck.
4. All cases of varicocele and ectopic testis.
5. Pregnancy.
6. Interstitial herniae.

Where a truss is indicated the utmost care must be taken to see that it is made to fit comfortably and efficiently.

ESSENTIALS OF A GOOD TRUSS.

1. Close fitting. If the fit is loose the support is useless, and worse than useless in that it gives a false sense of security. The truss must be worn next to the skin, and the measurements taken with such care that a close fit is ensured. If the fit is too close, in certain makes where there is elastic round the pelvis, there may be risk of compression of the sciatic nerve or skin irritation from pressure. This must be avoided.
In making the measurement the instrument maker or surgeon must remember that the truss lies obliquely. The measuring tape runs from the base of the sacrum posteriorly[60]. to just below the anterior superior spine laterally and thence to the upper margin of the symphysis pubis anteriorly. If a double truss is required one inch is added to the above measurements.
Before being finally completed the instrument must be fitted, and if necessary, adjustments made to ensure close fit. It must fit the patient in every position, squatting, stooping, rising and on abduction of the limbs.[61]

2. The truss having been fitted, must continue to function under all circumstances. It should especially be able to give support when the patient coughs or strains. The most efficient type, and the one which causes least irritation is that fitted with a compressible metal spring partially encircling the pelvis. If the curve of the spring is too acute it may cause irksome pressure. The spring should be made of highly tempered steel and capable of being opened out without snapping. Finally, the end of the spring must be so bevelled that it does not readily wear through the overlying leather.

3. Comfort is essential. Comfort with efficiency is difficult to attain. The patient should learn to regard the truss as a part of his clothing and find it no more uncomfortable to wear than his undervest. Comfort is increased if the instrument is covered with chamois leather, and if the pad is fashioned of honey-

combed rubber overlaid with soft leather. Finally, in the early days of its use the skin must be especially well cared for and kept dry.

4. Durability is a point of practical importance. A cheap truss wears out rapidly and is a poor investment. It is useful to possess two trusses the second being made when the first has been proven satisfactory. They should then be worn on alternate weeks to prolong their lives.

In support of the arguments for use of a truss, it is stated by Seeley[62.] that most Insurance Companies of America will accept as a good life risk a patient with a hernia who proposes to wear a truss, but will not accept the same case if he contemplates operation.

Keynes states that the large indirect inguinal hernia, and the direct which comes out close to the pubic spine are difficult to control with a truss and should not be supplied with one if operation can be performed instead.[58.]

A truss should not be recommended unless there is a definite contraindication to surgical treatment. Its value is limited, but in its own place, is of use. It must not be permitted to usurp other and more effective methods of cure.

For large herniae it is not to be commended.[63.]

Whilst there may always be a limited place for the truss in the treatment of hernia it must be regarded only as a palliative measure. Nevertheless, a few cases may be cured by the constant use of a well fitting truss, provided the hernia is small. Cure is effected by the same means as

that achieved by injection therapy, obliteration of the sac by adhesion formation as a result of chronic irritation. This happy result does not occur sufficiently often to justify its recommendation as a therapeutic measure.

RULES FOR TRUSS WEARING.

A patient who has been fitted with a truss must be instructed never to walk or stand without it, as if the hernia descends the risk of strangulation is greater. Finally, when he has a cough or when the hernia is large a light weight elastic truss should be worn at night.

COMPLICATIONS AFTER USE OF TRUSS.

If there is undue pressure upon the cord as it passes over the pubic bone varicocele, neuritis referred to the cord, or more rarely, testicular atrophy may follow.

THE CASE FOR SILVER FILIGREE WIRE.

In order to protect large areas of tissue defect, and to give support to areas where the available tissues are not sufficiently strong to be utilised for a repair, the technique of implanting a grid of silver filigree wire, shaped to conform to the defect, has been evolved and at present enjoys a vogue in certain centres.[64.]

Schede[65.] was the first to champion the use of silver wire in closing abdominal incisions with a view to preventing later development of hernia, and in the same year, 1900,

Witzel of Bonn published his method for closing hernial apertures by means of buried silver wire netting.[67.] Crede quoted by Meyer, first described the strong antiseptic properties of silver, and gave an impetus to these early attempts to use filigree.

Gopel[68.] published his experiences at almost the same time as Witzel, and performed his first operation in March, 1897.

These early workers experienced the same difficulties as their successors, and haematomata, sepsis and pain complicated their results. Meyer has emphasised, as do the surgeons of the Seamen's Hospital, Greenwich, that sepsis need not spoil the late results, and considered that the method offered vast opportunities for dealing with large defects in the abdominal wall, and with encouraging results. It must be remembered that in the days of its origin the method was a distinct advance, and that fascia or cutis had not been then conceived.

Cole has used this method extensively and advocates it for cases requiring repair. In the Seamen's Hospital, Greenwich during the five year period 1920-1924 inclusive, 663 hernias were operated upon, and of these, 97 were treated with filigree. Cole dealt with 60 and with uniformly good results. The late results were followed up in 20 cases which had been done five years earlier, and of these, three

had slight pain constantly in the wound, one had occasional pain in the wound, and one had a recurrence. Nevertheless, all were seamen and actively engaged in their duties. The operation became so popular in the hospital that several members of the visiting surgical staff permitted their own hernias to be treated by filigree.

The experience of Cole is not that of the majority, and it may be again remarked that in any hernial operation it is not enough for the operation to give good results in the hand of its designer, it must be capable of giving good results in the hands of any competent surgeon who follows carefully the correct technique.

Fitzmaurice-Kelly[69.] criticises filigree on the grounds of frequency of post operative sepsis with consequent need for removing the grid. This, with post operative pain in the area, is the common lot of the majority of workers with filigree and explains its comparative unpopularity.

McGavin[70.] remains a warm exponent of the method and has laid down certain requirement of technique. He insists that if they be followed, the end results should be satisfactory. He further states that sepsis need not spoil the end result.

1. The wire must be very pliable in order that the apparatus will at all times yield to body movements.
2. The mesh must be such that vascularisation may take place through it, otherwise it will be imperfectly fixed and lead to irritation and suppuration.

3. Strict asepsis must be observed throughout the operation. The grid must be placed in ether for ten minutes before use, and then in boiling crude soda to remove grease.
4. The graft must be larger than the defect it is required to support, and never err on the small side.
5. The wire used should be No. 28 standard wire gauge in size and be of pure silver.

80.

Barker also advises it for repair of large herniae.

The general experience with filigree is that it causes immediate post operative sepsis in an appreciable number of cases, and may lead to sinus formation which may not clear up until the grid has been removed; that it causes late post operative pain too frequently for satisfaction to be felt in its use; that it does not give a sufficiently high number of cures to justify its being used in preference to other methods, and that finally it may cause late post operative sepsis through acting as a foreign body. The method has not been well received generally and is not likely at this date to increase in favour. With evolution of other operations and on the basis of half a century of experience, filigree has failed to find a universal place in the treatment of hernia.

INJECTION TREATMENT.

The method of treating herniae by injection is very ancient and a wide number of substances have been used for the purpose. The rationale is to induce obliteration of the canal by formation of adhesions developed in consequence of an aseptic inflammation. A wide variety of solutions have

been used from the days of the Frenchman, Desault[71.] who died in 1795 and who favoured the use of red wine, to the present enthusiasts in America who prefer more complex fluids though perhaps lacking in the other attractions of their earlier predecessor.

SOLUTIONS USED.

Winters and Muirhead[72.] classify these into three groups.

1. Necrotic. These require the use of a local anaesthetic in advance, and produce a strengthening along the inguinal canal by means of a series of sterile abscesses and a subsequent white connective tissue organisation.

2. Esclerotic Solutions. The local anaesthetic is incorporated with these, and the solution infiltrates between the tissue cells of the inguinal canal with later formation of connective tissue.

3. Proliferative Solutions. These all have a small amount of chloretone incorporated with them, and, when injected into the muscles around the inguinal canal produce a true hyperplasia of muscle cells with a serous exudation into the canal itself which organises and produces fibro-elastic connective tissue. This is the type of solution which is most likely to give a permanently good result.

According to Meyer[73.] the ideal solution is

Zinc sulphate	1 gm.
Phenol Crystals	6 drachms.
Glycerine	4 fluid drachms.
Aqua Cinamoni	1 fluid ounce. Redistilled aq. 2 fluid ozs.

The mixture is filtered before use and in adults 8 to 16 minims are used per injection, in children, 2 to 4 minims.

INDICATIONS FOR INJECTION.

According to the warmest exponents of the method any hernia which is reducible should be treated by injection so long as there is no advanced systemic disease. Jameson [62.] and Cantala, Watson and Ignatz Meyer [41.] are enthusiastic in their praise and recommend it for almost every type. According to them one must know only the contra-indications, and these are:

1. The presence of incarceration or strangulation.
2. The presence of active venereal disease.
3. Diabetis mellitus.
4. Active or silent tuberculosis.

The exponents say that the procedure fell into disrepute only because many operators who tried injection failed to carry out the technique satisfactorily.

TECHNIQUE OF INJECTION.

It is not necessary to discuss this in any detail. Full descriptions are to be had in Meyer's papers and in Watson's monograph. In any event I lack the experience to do so and my opinions are here valueless. The salient points are:

1. The hernia must first be reduced and a well fittings truss worn and never taken off throughout the entire course of treatment. A special one must be worn for bathing, and fitted immediately after the ordinary one has been removed. This must be done with the patient

lying prone and the hernia must not be allowed to come down during the course.

2. The patient lies flat with the feet slightly elevated whilst the injections are being given.

3. The truss must be taken off before injection with the patient lying prone and reapplied before he rises.

4. Strict asepsis must be observed during each injection.

5. The injections are given every four to seven days, and in the dosage indicated above.

6. The first one is given to the area of the external ring and in a dose of two minims. Subsequent doses are determined by the reaction induced by the first.

7. Up to eight or ten treatments suffice to cure an average case.

8. The truss is worn for at least two months after completion of the course and removed at night. Further injections may be required. The truss is gradually discarded.

RESULTS OF INJECTION TREATMENT.

The results published by Mayer are so satisfactory that one wonders what wizardry he possesses, and also why many other people have been less fortunate. He says that failure in others is due to their failing to follow the correct technique, and, in his several contributions has laid down the technique in detail for those who care to follow it. Despite this, the method has not become popular, in this country at any rate.

Mayer used injection therapy for twenty-eight years, and, in the first five years had a ten per cent. recurrence,

in the next five 3.5% and less than two per cent. since then. He attributes his good results in part to avoiding cases 'where there are contra-indications'. Mayer dealt with 200 cases of recurrence after previous surgical treatment, and succeeded in curing all but three.

Jameson and Cantala report four failures out of a series of 64 cases.

It would seem from a review of the literature on the subject, that the method is one which must be thoroughly mastered before good results become attainable, and that moreover one must be possessed of a good deal of patience to carry each treatment through to its successful conclusion. There seems to be no reason to doubt the accuracy of the published figures, but there is reason to believe that the cases may have been carefully selected. Even Mayer admits that there is still a place for surgery proper, and does not claim to cure the largest examples.

As a footnote here it may be recorded that one case at least has been treated by injection of paraffin wax into the canal. The patient later complained of the presence of a painful swelling. This was removed by Wood of Philadelphia who had the tumour analysed. It was found to be composed entirely of paraffin wax. The case was reported but the name of the person who injected the wax, and clinic were performed were not disclosed.

DISCUSSION ON THE VARIOUS METHODS OF TREATMENT.

One has thus shown that there are six accepted lines of treatment available for the treatment of inguinal herniae.

1. The group of Bassini Operations.
2. The group of Fascial Operations.
3. The use of silver filigree wire grid.
4. The use of a truss.
5. The adoption of injection therapy.
6. Simple Herniotomy.

The first four apply to all types, the last two to indirect only. It has been demonstrated that the truss may have a place of its own in selected cases, but that there is no universal acceptance of either injection treatment or silver filigree now. The methods therefore resolve into a choice between three, herniotomy, with or without buttressing of the fascia transversalis fascia, fascia or Bassini.

The indications for simple herniotomy are absolute. They are:

1. All infants.
2. All children.
3. All small indirect inguinal herniae in adults where the muscle and sphincteric tone of the canal is good.
4. Those moderate sized indirect hernias of adults where the muscles and sphincters are in a state of temporary weakness, as for example after illness associated with onset of a hernia, but where recovery will be associated with local and general increase in muscle tone.

The contra-indications to simple herniotomy are:

1. All direct and recurrent inguinal herniae.
2. All large and chronic herniae where muscle and sphincteric tone in the canal has been lost.
3. Where there is an associated factor predisposing to recurrence such as chronic bronchitis, bronchiectasis, intractable constipation or the need to continue in an occupation causing severe physical strain, and the patient elderly or the hernia large.
4. Obesity accompanied by muscle flabbiness and excess of extraperitoneal fat.
5. All traumatic herniae.
6. All sliding herniae.

The results of simple herniotomy are excellent and have already been quoted. Technique will be described in a later chapter.

Those cases which are unsuitable for simple herniotomy must be dealt with by another method, and it has been established that the Bassini procedures are unsatisfactory from every point of view, they not only fail in their object, which is to afford protection to all possible weak areas in the canal, but they actually predispose to recurrence. It therefore follows that the method of choice is supplied by fascia. Fascia, however, has certain disadvantages.

DISADVANTAGES OF FASCIA.

1. The McArthur method, by cutting strips from the external oblique aponeurosis does not give enough fascia to fulfil the requirements of the average case. For a large hernia it is not ideal.

2. The Gallie technique involves either an extensive incision in one thigh, or a small incision combined with the use of a fasciotome. In either case, there is a risk of post-operative pain referred to the thigh of the affected side, and the possibility of obvious muscle hernia. This pain may be aggravated by exercise, and, in my experience, occurs in 25% of subjects, though to a widely varying degree, and in none is it so severe that life is made intolerable for the sufferer, nor does he desire an operation for its relief. The etiology of the pain is obscure, and is not necessarily due to muscle hernia, because it is not always cured by repair of this condition. The pain has a definite bearing upon the use of fascia, and, in those cases of hernia where a workman's compensation suit is impending, may be a matter of consequence.

3. Infection of the wound in the abdomen is more frequent with fascia. Bendick[75] found sepsis to be present in 7.9% of his cases where autogenous fascia had been used, and in 12,1% where ox fascia was used. Beekman and Sullivan[76] admit the increased liability of sepsis in fascial operations owing to the increased operating time necessary for their performance. In my own series of 120 fascial repairs mild sepsis developed in five and moderate in 2. In 1, healing was delayed until the thirty-fourth day. The others were healed by the twenty-first day.

4. There is also an increased liability to develop post-operative complications, owing, it is considered, partly to the increased operating time, and partly to another factor.
Churchill and McNeil[77] investigated the reduction in vital capacity following upon abdominal operations. They found that it varied with different types of operation and of incision. They established that there is a relationship between the incidence of pulmonary complications for a particular type of incision or operation, and the reduction in vital capacity associated with that procedure. Where there is a plastic repair

and reflex muscle spasm, the reduction in vital capacity is more marked. In simple herniotomy this is minimal, whilst in fascial herniography it is considerably greater. The relative incidences of 'post-operative chests' is in accord with this finding.

78.

5. Fascia will unite to fascia under considerable tension and it may be applied under tension to unite the conjoined tendon to Poupart's ligament, or, it may be darned loosely between the two structures. In either case there are potential gaps between the strands of fascia, and not always do all the strands unite with one another. Potential gaps exist, and recurrences of the direct type may develop. In the recurrences operated upon by myself after previous fascia repair, with one exception, the sacs have been of the direct variety, and found close to the medial end of the canal. In several, the fascia had clearly presented a potential defect through which the sac had insinuated itself, yet, in other parts had effected a powerful reinforcement.

6. The needle used for a Gallie repair is large, and apt to traumatise the inguinal ligament. The significance of this is obscure, but an impression exists that it may predispose to formation of direct or femoral recurrence. There is also a risk of penetrating the femoral vein. This complication has been mentioned in the literature and has occurred, I am confident, on many more occasions than have been reported. This may present an extremely difficult haemorrhage to control, and in one which came to my notice, death resulted on the operating table.

79.

7. Finally, there remains a substantial recurrence rate, and the figures quoted above may be regarded as the best available. Even there, especially for the direct variety, the figures are too high, and in the hands of many surgeons are higher for both types.
It must surely be admitted that whilst fascia has results superior to those of the Bassini, there is no room for complacency and that if any other procedure can be devised which might be better, that it should be given reasonable consideration.
It is the purpose of the author to suggest a new method of repair and to report the results in 100 cases which have been dealt with by this new technique. The results will be severely analysed and subjected to detailed consideration and criticism.

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CHAPTER 13.

CUTIS AND WHOLE SKIN GRAFTS IN HERNIA REPAIR.

THE USE OF CUTIS GRAFTS IN HERNIA REPAIR.

Rehn[1.] and Loewe[2.] advocated the use of a method known to them as 'the Cutis Graft Method for the Repair of Anatomical Defects in Post-Operative Herniae', and of these Rehn was the first to apply the principle clinically.

The term cutis was coined because, though derived from the skin, it is not a true skin graft, being defective in epidermis. Cutis contains all the elements of the skin excepting the epidermis, it is elastic, inherently active, and composed of a rich network of connective tissue fibres. After transplantation, according to Uihlein[3.], these inherent factors persist in the metamorphosis of the graft, and, owing to the stimulus initiated and maintained by the tension under which the graft is sutured, a metaplasia into stout connective tissue takes place.

Rehn and Schwartz quoted by Uihlein[3.] performed a tenotomy of the tendo Achilles in a dog, and repaired the defect with cutis graft. They found that a gradual metamorphosis took place after ten weeks, into a tendon difficult to differentiate from ordinary tendon. When the experiment

was repeated with fascia, regeneration was more slow and repair less complete.

Kitel[4.] showed quite conclusively that cutis lives longer, is more active than fascia, and thus more suitable for plastic repair. He removed pieces of human fascia and cutis at operation, and performed metabolic studies upon them by the Warburg technique. His findings demonstrated the superior viability of cutis over fascia, and determined that this held good for both sexes and for all age groups.

Rehn applied his cutis graft, which he took from the thigh, into the defect requiring plastic repair, and attached it under a maximum degree of tension to its surrounding structures by interrupted sutures. The graft was cleared carefully as far as was possible, of epidermis.

Uihlein was afforded the opportunity of operating upon two patients who had submitted to a cutis graft repair four years earlier. Sections were removed for examination. He found that there was a complete metamorphosis of the transplant. The grafts represented normal connective tissue with its fibrous and fatty components, blood vessels and nerves. No hair follicles or glandular tissue could be identified and there was no evidence of cyst formation, either macro- or micro-scopically. He did, however, note the presence of large cells with clear deeply staining nuclei and lying in rows or rings. These were interpreted

as being remains of hair follicles or glands, surrounded by giant cells, macrophages and lymphocytes. No scar tissue was seen in the sections examined.

Rehn used this method in 65 gross post operative herniae with six poor late results. There were a further 39 operations where cutis was used to fill in a tissue defect, and of the total of 104 operations for various purposes, fifteen were complicated by wound sepsis.

Cannaday[5, 6] has described his experiences with cutis repairs. He and his associates in the Charleston General Hospital used the method in 37 cases, of which 27 were herniae of various types. Two operations were followed by mild sepsis and two by small haematomata. But these workers warmly applauded the principle and state that cutis is superior to fascia. They found that the graft heals firmly and promptly, and commended the fact that cutis is easily obtainable in portions as large as necessary for any given case.

Histology of Cutis Implants. Neither Cannaday and his co-workers, nor Rehn and his associates have investigated with detail the histology of the grafts, but are agreed that clinically the results are excellent. A good deal of work has been done by others in connection with cutis implants, though here they were not sutured under tension, but merely embedded into the tissues. The workers who adopted this

method have been plastic surgeons, and of these, Peer and Paddock[7.] have investigated the problem most thoroughly. Eitner,[8.] and Peer and Paddock found that despite every attempt to remove the epidermis, apices of hair follicles and sweat glands were still to be found in the grafts, and that when implanted, these structures disappeared, and the grafts were gradually transformed into fibrous tissue. They observed that the grafts fused with their surroundings through the mechanism of inflammation and repair associated with aseptic wound healing.

Peer[9.] conducted a detailed investigation into the fate of cutis implants during a large series of nasal reconstruction operations. He stored pieces of derma with cartilage beneath the skin for periods up to two years, and studied sections prepared from these at varying intervals. He observed a gradual degeneration of the normal skin structures with disappearance of the hair follicles and sweat glands at an early stage. These were replaced with fibrous tissue. The investigations raised the old question as to danger of epidermoid cyst formation, and, as this is an objection frequently raised to the use of cutis implants, it is well at this stage to consider it thoroughly.

Inclusion and Epidermal cyst. Garre[10.] found that implantation of epidermis alone produced a smooth walled cyst, whilst in the cyst rising from a dermal implant, skin

papillae were also present in the wall.

The comb of a cockerel has no hair follicles or glandular structures, and was thus selected as the object of an experiment by Kaufman[11.] in 1884. An eliptical incision into the comb was made, and the edges of the wound closed over the enclosed elipse of tissue. A cyst was formed which could only have arisen from epidermal elements.

Zimches[15.] buried free strips of whole thickness skin into the muscles of dogs, and studied the implants up to two years. His conclusions may be summarised:

1. The epidermis of the implant curves up in a U shape, the margins of the U meeting during the fourth week to form a closed cavity lined with epithelium.
2. The cyst continues to grow because the lining epithelium constantly produces cornified cells which are shed into the lumen. Part of the content is made up of epithelial debris and broken down hairs.
3. Secondary cysts may develop from hair follicles.
4. The implanted section of skin heals in its new bed and rapidly fuses with its surroundings by means of granulation tissue later organised into tough fibrous tissue.
5. No metaplasia of epithelium was noted or malignancy observed at any stage.

Peer and Paddock had an unrivalled opportunity for studying cutis implants in the human subject during their plastic operations, and their findings may be summarised briefly:

1. The embedded graft fuses with its surroundings.
2. In spite of attempted complete removal of the epidermis, epidermal tissue remains in the majority of cases, and this remaining epidermis forms closed cyst cavities of

microscopic size containing horny material and fragments of hair.

3. Sebaceous glands were observed only in sections up to one week after implantation.

4. Hair follicles could not be detected after the third week.

5. In sections after six months the sweat glands were degenerating and undergoing fibrous replacement, but could not be detected in every section examined.

6. The tissue was surrounded by a granulomatous reaction of the chronic inflammatory type which contained epithelioid cells, giant cells, macrophages and lymphocytes. The giant cells frequently contained foreign bodies such as hair fragments.

It must be remembered that in all of these cutis implants the grafts were inlaid into the tissues and not sutured under tension. It is possible that their fate would be modified by such a procedure, and the findings in practice of Rehn, Uihlein and Cannaday suggest that the risk of post-operative cyst formation is improbable.

In the two cases examined by Uihlein two years after implantation, the implants showed no signs of cyst formation even under the microscope.

The method of using cutis for hernia repairs has not been adopted generally, and much data remains to be collected before useful figures will become available for consideration, but with the data to hand certain facts have come to light.

ADVANTAGES OF CUTIS REPAIR.

1. Cutis is readily available and in sizes to meet any surgical requirement.

2. Cutis is proven experimentally to be superior to fascia in its inherent qualities of elasticity, viability and capacity to undergo metamorphosis into fibrous tissue.

3. The results in practice for repair of tissue defects have been found by those few workers who have adopted the cutis graft technique, to be entirely satisfactory.

DISADVANTAGES OF CUTIS REPAIR.

1. The main disadvantage is that the cutis required to be cut from one part of the body, generally the thigh, before implanting, and the bed from which it is removed, in the experience of the Germans and Americans, may take long to heal.

2. A wound is added outside the hernia area which from a cosmetic point of view may leave the patient dissatisfied.

3. The incidence of sepsis, 15 out of 105 cases of Rehn is too high for satisfaction.

4. There is loss of time in preparing the graft and repairing the thigh wound. It has been shown that post-operative complications increase proportionately to the length of operating time, and it is desirable, so far as possible, not to prolong any operation unnecessarily.

5. In Rehn's cases, healing of the wound in the thigh was frequently prolonged owing to the fact that the wound margins were denuded of epidermis and stitching was unsatisfactory.

WHOLE SKIN GRAFTS IN HERNIA REPAIR.

In 1938, I was confronted with the problem of repairing a large ventral hernia in a woman aged sixty-four.

For the first time, I implanted a large whole skin graft, having excised and closed the redundant peritoneum. The graft was sutured to the anterior aspects of both rectus sheaths, and to the medial aponeurotic expansion of the external obliques. The graft measured some four inches by five, and was taken from redundant skin excised by an eliptical incision. The repair was firm and satisfactory. Eighteen months later there had been no recurrence or other complication. Between 1938 and October 1943 a similar method of repair was adopted in seven large ventral, three umbilical, and one epigastric hernia. In none was there any complication during the post-operative period, but, unfortunately, owing to the War situation and the resultant migrations of myself and the population generally, none of the cases were followed up for more than a few months. The immediate results, however, had been so encouraging, that it was determined to use the same method for the repair of inguinal herniae, and to investigate the histology of the implants.

Cannaday's papers were published in 1943 and 1942 and Uihlein's in 1939. At the time of my original whole skin implant I was unaware of Rehn's work, but the papers indicated influenced my thoughts during the later repairs until October, 1943. By 1943, with the experience of several ventral hernia repairs by the whole skin method and

the information of Cannaday and Uihlein for consideration, it appeared to me that there was no reason why whole skin grafts should not be used instead of cutis implants. Were such a method found to be safe, and to give results which were satisfactory, the need for inflicting a thigh wound would be obviated, and there would be a saving in operating time.

It was considered necessary before coming to any final judgment on the merits or otherwise, of the idea, to investigate the histology of whole skin implants sutured under maximal tension, in a series of animals, and then to perform the operation on a considerable number of human subjects paying special attention to all post-operative complications, and finally studying the end results at a time not earlier than one year after operation.

In Woodend and Oldmill Emergency Hospitals, Aberdeen, there is a constant high number of admissions suffering from inguinal hernia, and of these, the greater number are civilian. During the period April 1st, 1942 to 1945, a total of 123 fascial repairs, 88 Bassinis, 94 simple herniotomies and 149 whole skin grafts have been performed by myself. It was thus obvious that there was an adequate number of cases for discussion on a comparative basis, and in view of the fact that almost all could be traced and re-examined at intervals, the facilities existed for carrying out the work.

The animal experiments were conducted in the laboratories of the City Hospital, Aberdeen, and for the purpose of the work the rabbit was selected as being the most suitable animal. A number of guinea pigs were also used, but their expectation of life being uncertain, rabbits were later used throughout.

It is appropriate to discuss the nature and results of these experiments, before proceeding with their clinical application to the human subject.

EXPERIMENTAL EVIDENCE IN FAVOUR OF WHOLE SKIN GRAFT IMPLANTS.

A knowledge of the properties and histological anatomy of normal skin is necessary before investigating the changes which follow implantation.

HISTOLOGY OF NORMAL HUMAN SKIN.

Preparation of Blocks.

Fixing. Before examining the skin it is necessary to fix and harden it so that its elements may retain so far as possible the characteristics which they possess in the living state. These reagents used for hardening and fixing act chiefly by coagulating the semi-fluid elements of the tissues and rendering them incapable of being dissolved out in the after-treatment. The following practical points

were observed in fixing and hardening specimens examined during this work.

1. The tissues were removed fresh and immediately transferred to the fixing agent.
2. The reagent used was formalin. That is a 40 per cent. aqueous solution of formaldehyde gas diluted with 9 times its volume of physiological saline.
3. The reagent was used for as short a time as necessary to fix and harden the tissues and not for longer. Prolonged use can cause shrinkage.
4. The tissue was placed in a wide mouthed bottle on the bottom of which was a small piece of cotton wool to minimise distortion.

Imbedding. The specimens, having been fixed, require to be imbedded. Two substances are commonly used for this purpose - paraffin and celloidin. By the first method, melted paraffin is made to permeate the tissues, and this solidifies on cooling. In the second method a solution of celloidin in alcohol-ether is used, and by evaporation of the ether the requisite hardness is obtained. Both methods are applicable to skin histology, but each has advantages and disadvantages. The skin, both in the normal and abnormal state, is difficult to cut into thin sections, the chief reason being that the corium offers a greater resistance to the knife than does the Stratum corneum. Also it is

necessary that the specimen of tissue should be placed so that the epidermis is towards the cutting edge of the knife. If the corium be cut first, the epidermis will generally be torn.

Cutting. In this work the paraffin method of imbedding was used. Thereafter the tissue was blocked and prepared for cutting. Most of the specimens were cut by a rocking microtome, but not all. A 100 sections were cut from each block and every tenth was stained. Numbers 1, 3, 5, and 7 were stained with haematoxylin and eosin. Numbers 4, 6, 8 and 10 by Weigert's elastic tissue stain and Van Gieson, and numbers 2 and 9 by the Mallory method, In addition, two other serial sections were selected at random and stained, the first with Van Geison and the second with haematoxylin and Biebrich. Where sepsis was suspected a section was stained by Gram's Method for organisms.

There was some difficulty in cutting most of the blocks. Hardness of the block often lead to some fragmenting of the sections, but, on the whole the specimens were satisfactory.

Histological Appearances of Normal Skin.

EPIDERMIS.

The Development of the Human Epidermis.

In its primitive condition in the blastodermic vesicle the epidermis consists of a layer of polygonal nucleated cells, known as Rauber's layer, and beneath it a layer of cubical cells with large round nuclei.

Between the first and second months of embryonic life three layers of cells are present, namely the superficial Rauber's layer, the cells of which have become flattened, and two layers of cubical or columnar cells. By the end of the fourth month the epidermis consists of five or six rows of cells, a superficial area of flattened cells, a deep layer of columnar and several of polygonal intervening. In the nuclei of the cells of the deepest layer mitotic figures can be detected.

By the sixth month a marked proliferation has taken place in the epidermis. There is increased vascularity of the underlying corium and the pressure exerted by the superficial blood vessels has caused the formation of the papillae and forced the proliferating epidermis to grow down between them to form the interpapillary processes. By the seventh month the polygonal cells of the epidermis have become differentiated and present all the characteristics of prickel-cells. About the eighth month two or three rows

of cells near the surface of the epidermis become granular in appearance, owing to the presence within them of variously sized irregular granules of a substance named keratohyalin. The most superficial cells of the epidermis have been transformed by this time into cornified cells or horn cells, and form the layer known as the Stratum corneum.

The fully formed human epidermis is generally divided for descriptive purposes into five layers, which are named from within outwards.

1. The basal layer, or Stratum germinativum.
2. The prickel-cell layer, or Stratum malpighii.
3.. The Stratum granulosum.
4. The Stratum lucidum, and
5. The Stratum corneum.

Such a division is useful, but arbitrary, as these layers are ill-defined and should be considered not so much as special layers but as stages in the gradual evolution of the basal columnar cells till they become cornified squames.

The Basal Layer or Stratum Germinativum.

This is the deepest layer of the epidermis and is next to the corium. It dips down between the papillea to form the interpapillary processes. The cells are columnar with oval nuclei and extend one layer deep. They are united together and to the overlying cells by protoplasmic fibrils which protect the interepithelial spaces. At their

bases the fibrils form tufts which project downwards into the corium and give rise to a denticulate line of demarcation between the two layers.

In pigmented regions in white races and throughout the skin in dark races, the cells of the basal layer contain numerous brownish pigment granules found chiefly at the superficial poles of the nuclei. Interspersed between the basal cells are the melanoblasts which can be demonstrated by special staining with silver nitrate.

The germinal layer is the source from which the whole of the epidermis is developed. Its cells are constantly dividing, and their whole function is that of proliferation. The daughter cells are pushed towards the surface by new layers of cells forming beneath them, and becoming more and more differentiated until they evolve into horn cells.

The Prickle Cell Layer or Stratum Malpighii.

Above the basal layer the cells are polygonal in shape, and instead of being arranged in rows, form a mosaic. Towards the surface they are more flattened. The nuclie are roundish in shape in the centre of the layer and oval where it merges into the granular layer. The nuclei have a well marked chromatin network and one or more nucleoli. The cells of this layer are in organic connection with one another by means of fine radiating protoplasmic fibres, so that the layer has been likened to one vast cell with

numerous nuclei. At one time it was believed that each of these cells was surrounded by a set of protoplasmic spicules, like the prickles on a prickly pear, and on this account were named prickle cells which term remains to the present day.

These protoplasmic fibrils appear delicate but are in fact comparatively strong. A peculiar pseudogranular appearance is presented by the prickle cells if their surface is intact, as the prickles are then spicular in shape towards the periphery of the cell.

The Stratum Granulosum.

Towards the surface the prickle cell layer merges into the granular layer, consisting of flattened cells containing numerous granules. The thickness of this layer varies from one to four cells, and these lie closer together than do the prickle cells. Their prickles are shrunken and the nuclei smaller and paler. The nature and origin of the granules which fill the cells of this layer is doubtful. The granules vary in shape and size from small round specks peppered through the cell protoplasm, to irregular course lumps. The substance of which the granules are made has been called keratohyalin, although it has no chemical relationship to either kerotin or kyalyn. It is believed to be derived from the intracellular fibrillary network, and is a solid or semi-solid substance

which can be stained by gentian violet, carbolfuchsin, picro-carmine, and haematoxylin, which last is the most satisfactory reagent.

The Stratum Lucidum.

Superficial to the granular layer is a thin layer of cells, the Stratum lucidum, so called because, when well developed it may be seen as a semi-transparent line across the section resembling an oily streak across a sheet of paper. The cells are larger and more irregular in shape than those of the deeper layers. The prickles are more shrunken and the nuclei more shrivelled. The granules have disappeared and are replaced by an oily looking substance called eleidin, which is present not only within but between the cells, and is the chief characteristic of this layer. It rarely, if ever, completely fills the cells but generally occurs as droplets of varying size which tend to run together to form miniature lakes.

Eleidin is a protein substance which is difficult to stain and no attempt was made to investigate it through this work, as it was of no special importance from my point of view.

Stratum Corneum.

This is the most superficial layer of the skin and that which we see and touch. It is the layer which gives

the skin its power of resisting the entrance of micro organisms and harmful liquids. It varies in thickness in different parts of the skin, and is composed of epidermal cells which have undergone the process of cornification and are known as horn cells.

Horn cells vary in size and shape, according to their situation. The most perfect example is located immediately above the Stratum lucidum, while towards the surface of the skin, alterations from drying and pressure produce the flattened degenerate type known as a squame. This is rubbed off constantly by the friction to which the skin is subjected. The perfect horn cell is not degenerate, but rather the most highly evolved cell of the epidermis. It is polygonal and has a central space from which the nucleus has completely disappeared. The eleidin of the cell has given place to a fatty or waxy substance and the peripheral portion of the spongioplasm is in part transformed into a highly resistant material called keratin. This layer acts almost like an impermeable varnish over the skin.

THE CORIUM.

The corium is the dense fibrous layer of the skin which is situated beneath the epidermis. It supports and protects the hair follicles, glands, nerve terminations, blood vessels, lymphatics and fat cells, and it is to this layer that the skin owes its strength and elasticity.

Structurally, it is built up chiefly of white fibrous and a variable amount of yellow elastic tissue, while connected with or independent of these fibres are certain cellular elements.

The corium is described as having a superficial layer known as the papillary and a deeper, or reticular layer. There is no definite line of demarcation between the two. Deep to the reticular layer is the subcutaneous tissue, which must be regarded as the deepest layer of the corium where the cells have become differentiated by containing fat.

In the papillary layer are found white fibrous bundles, thin, loosely packed and with a vertical disposition. In the reticular layer these bundles are more numerous, are thick and run in various directions to form a complicated network, which has small diamond shaped meshes.

The epidermis lies upon the papillary layer of the corium and is dependent upon it for nutrition. There is no basement membrane between the two layers.

The actual papillae are conical projections of the corium in which are found terminal loops of blood vessels, and nerve terminations. The papillae vary in size in the skin of different parts of the body, and are usually about twice as long as they are broad. They are less dense than the epidermis, from which interpapillary processes penetrate

deeply into the corium. Alterations in the papillae will be reflected in the epidermis.

Development of the Corium.

The corium differs from the epidermis in being developed from a totally different layer of cells of the blastoderm.[17.]

The primitive ectoderm of the blastodermic vesicle gives origin to the epidermis and its appendages. From the mesoderm develops the corium and blood vessels. The early beginnings of the corium are seen at the end of the second month of foetal life as a layer of cells, round or spindle shaped and known as Remark's skin plate.

At first these cells are round with actively dividing nuclei, and show amoeboid movement. They gradually become spindle shaped. Branching occurs at the extremities, and these branches unite with those of neighbouring cells to form an irregular network of embryonic connective tissue in the meshes of which is a semi-fluid substance of muco-albuminous material. The tapering branches of the cells lengthen and split into several fine fibres, which later develop into white fibrous bundles. The remainder of the branch gradually splits up, while the nucleus remains central being often surrounded by a halo of undifferentiated protoplasm.

Some of the round cells remain undifferentiated, but acquire the function of reproduction.

There are thus two elementary types of cells in the corium,

1. The differentiated cell, where the nucleus persists and the protoplasm has been replaced by a fibrous bundle, and
2. the round cell which is not differentiated into fibres.

Elements contained within the Corium.

These elements are both cellular and fibrous.

Cellular elements.

The cellular elements may be divided into:

(1) Mobile cells.

- (a) Blood cells.
- (b) Histiocytes

and

(2) Fixed cells.

- (a) Connective tissue cells.
- (b) Vacuolated cells.
- (c) Mast cells.

Mobile cells.

These are the various forms of leucocytes which are found in the corium. They are never numerous and are mainly located in the papillary layer. The polymorphonuclear

leucocytes are easily identified, but small monocytes or lymphocytes may be practically indistinguishable from young connective tissue or fibroblasts.

Histiocytes have large oval nuclei and correspond to the monocytes in the blood. They are difficult to distinguish from fibroblasts. These histiocytes are of importance in that they are capable of taking up lipoids to form characteristic foamy cells.

Fixed Cells.

Connective tissue cells.

These vary in shape and size but are generally large and often spindle shaped. They have processes which branch and taper to fine threads uniting with those of other cells to form a meshwork.

The nucleus varies from oval in the spindle shaped cell to round when the cell is polygonal. The nucleus has an open intranuclear mesh and is described as being vesicular, contrasting with that of the mononuclear leucocyte where the mesh of the nucleus is small and close.

Round connective tissue cells are uncommon, but in sections spindle cells cut transversely may appear round.

In young connective tissue numerous cells occur in which only the nucleus is visible and no protoplasm can be detected around it. These are known as fibroblasts and are

capable of evolving into fully formed connective tissue cells. They are slightly larger than mononuclear leucocytes and may be almost indistinguishable from lymphocytes.

Vacuolated Cells.

These cells have no processes but their protoplasm is vacuolated. They do not appear to develop into white fibrous tissue, but rather retain the more simple function of reproduction.

Mast Cells.

These differ from the other connective tissue cells in that their protoplasm contains numerous coarse granules. They vary in shape and size being round, spindle shaped, polygonal, branched or oval. They are obvious under the microscope owing to their coarse darkly stained granules. Mast cells are always present in the healthy corium, but not in large numbers and mainly in the neighbourhood of blood vessels, hair follicles or sebaceous glands.

The origin of these mast cells is obscure.

Fibrous elements of the Corium.

White fibrous bundles (Collagen).

Collagen is the name given to the albuminoid substance of which white fibres are composed.

Collagen bundles are composed of fine fibres united

together by a semi-fluid interfibrillary substance which is closely allied to mucin. The bundles vary in thickness according to the number of fibres which compose them. They present a wavy appearance when viewed longitudinally. This appearance is no longer seen when the skin is stretched. Collagenous fibres are incapable of branching and uniting to form a network like elastic fibres, but as the bundles are frequently split and join again, a course pseudo network may be produced.

Collagen is an albuminoid substance and is probably an anhydride of gelatine.[17.]

Elastic Fibres.

Elastic fibres appear as homogeneous light-refracting threads, which are widely distributed throughout the corium and subcutaneous tissue. They are straight or slightly wavy, angular in cross-section, can branch at varying angles and anastomose to form a more or less continuous network. The fibres are thin in the skin of the abdomen, and broadest in the sole of the foot. When stretched, the elastic fibres easily break across without splitting and tend to curl up.

Elastic fibres are arranged parallel or obliquely to the collagen bundles of the corium, and are most dense in the reticular layer where they form a network, the meshes of which tend to be elongated horizontally. From this mesh-

work finer fibres pass vertically up, and split into fibrils, which end between the cells of the basal layer of the epidermis. Fibrils also pass downwards into the subcutaneous tissue. Elastic fibres envelop the sweat ducts and glands, sebaceous glands, nerve terminations, and hair follicles. They do in fact, form a skeleton which supports and holds together the various elements of the corium and subcutaneous tissue.

Recent observations have shown that their elasticity is not so great as was formerly supposed, and that when they are even moderately stretched they rupture. Their elasticity is less than that of the collagen fibres and their chief function is support. The elastic fibres are composed of an albuminoid substance named elastin.

These fibres do not appear in the skin until about the eighth month of foetal life, and their origin is still not certain.

It is doubtful whether new elastic fibres can form in the skin after the tissue has been destroyed by rupture, inflammation or necrosis. When the fibres have ruptured they do not seem to possess the power of growing together again as do the ends of a ruptured nerve.

Hair.

Hairs are present on all areas of the human skin

excepting the palms, soles of the feet, red parts of the lips, inner surface of the prepuce, inner surface of the labia majora, glans penis, and dorsal aspect of the terminal phalanges of the fingers and toes. But the number of hairs present varies in different parts of the body, and in the same part of the body between different subjects.

In health the hair tapers to a fine point. In section it may be circular, oval or may form angular or irregular figures. Curly hairs are generally oval in section, while straight hairs are circular.

They vary greatly in length and thickness, being thinnest on the trunk and limbs, and thickest in the scalp, beard and about the genitalia. In the skin of the trunk from which skin grafts are most likely to be taken for the purpose of repairing an anatomical defect, the hairs are implanted obliquely into the corium, and may be either short or long. The hairs are implanted in invaginations of the skin near the hair follicles, and usually there is one hair in each follicle, though two or even more may be present.

The hair consists of a shaft which widens out at the lower end of the hair follicle into a bulbous extremity or root. This root is indented at its lower end by the up-growing conical vascular process of connective tissue, known as the papillae. When the hairs are long, the root and

the lower part of the follicle are situated in the sub-cutaneous tissue, but when short, they are found in the pars reticularis of the corium.

The shaft of the hair like the root, can be seen on section to be composed of three parts, a fine layer of outer cells called the cuticle, a stout middle layer comprising more than two thirds of the hair and known as the cortex, and finally the core or medulla.

Pigment is found mainly in the cortex.

In regard to the hair follicle, in its upper third its cells are similar to and continuous with those of the epidermis, but in the lower two thirds, the horny and transitional layers disappear leaving only the prickle cell and basal layer. The epidermal portion of the follicle is enveloped in a tissue sheath of connective tissue, derived from the corium, and at the junction of the middle and upper thirds of the follicle, the sebaceous glands which relate to the follicle, open into it to lubricate the hair.

In the rabbit, differentiation into the numerous layers which characterise the human hair, is not so complete, and the rabbit hair is a simple structure by comparison with that of the human.

THE SEBACEOUS GLANDS.

These are small, saccular, or racemose glands, which occur in the skin, and usually in connection with the hair follicles. The glands are generally situated on the under side of the hair follicle in the angle between it and the erector pili muscle. Those relating to stiff hairs are quite small while those belonging to the fine lanugo hairs are large. The number of saccules which compose the gland, vary from one to twenty or more. The saccules open into a common duct which discharges its content into the neck of the follicle to lubricate the hair. The glands unconnected with hairs open directly on to the surface of the skin.

THE SWEAT GLANDS.

The sweat glands are simple tubular glands composed of a body consisting of several turns of a tube, and forming a coil which is found either in the reticular layer of the corium, or in the subcutaneous tissue, and a duct which traverses the corium in a spiral manner, passes through the epidermis, and either opens on the surface of the skin at the sweat pore, or in the wall of the hair follicle above the opening of the sebaceous glands.

Small round glands open at the sweat pores, while those which open into the hair follicles are known as

apocrine glands, and are larger.

The small sweat glands are distributed over the skin of most of the body including the palms and the soles. The large glands are found in the axillae, nipples, around the anus and in the genital region.

Muscles.

The muscles of the skin consist of the arrectores pilorum and the layers of involuntary muscle fibres which are found in the areolae of the nipples and in the dartos of the scrotum.

The arrector muscles of the hairs are involuntary and located below the sebaceous glands, whilst inserting into the fibrous coat of the hair follicle. They are enclosed in a fibrous sheath in which elastic fibres are present. They are most highly developed in relation to the scalp.[18.]

Involuntary muscle fibres forming layers are found in the dartos of the scrotum, in the nipples, and the eye-lids.

In rabbits and many other animals a fine layer of involuntary muscle is found in the deepest part of the stratum corium of the skin. These muscles are stimulated to contract by cold and on contracting cause wrinkling of the skin.

Blood Vessels.

These derive from a deep plexus situated about the junction of the corium and the subcutaneous tissue, and form a plexus in the sub papillary layer.

From the deep plexus, branches pass to the fat lobules, sweat coils, hair follicles, and sebaceous glands, while from the superficial plexus, branches are given off to supply the papillae, the upper portion of the hair follicles, and the sweat ducts. There is a rich anastomosis between the various blood vessels in the skin and clean incisions heal rapidly in consequence.

Lymphatics.

The skin contains lymphatic vessels and also lymphatic spaces which lie between the fibrous bundles and the epithelial cells.

The lymphatic vessels possess a definite endothelial lining in contra distinction to the spaces which are simple spaces containing lymphatic, but with no distinguishing wall and located between the fibrous bundles or epithelial cells.

There are comparatively few lymphatic vessels, but an appreciable number of lymphatic spaces exist.

It has also been established that lymph circulates in the epidermis.

Nerve Terminations.

Both medullated and non-medullated nerve fibres are present in the skin.

The skin is richly endowed with sensation. The precise nature of the nerve terminations is interesting and has been the subject of much research. It has, however, little relation to the present subject.

Changes in Skin after Implantation.

Changes in all the structures contained in the skin are early demonstrable after implantation, and are illustrated in the following figures.

TECHNIQUE OF ANIMAL EXPERIMENTS.

The rabbit was used for most of the operations, and the types chosen were healthy Chinchilla bucks.

The hair on the dorsum of the back was cut short by barber's fine meshed hair clippers and scissors to expose an area of skin measuring approximately five inches by three.

The animal was then anaesthetised by open ether without preliminary premedication.

An incision was made along the lumbar vertebral spines and the lumbo-dorsal fascia exposed. An area of the fascia was excised and the defect closed by a whole skin graft cut from the edges of the skin incision. The graft

measured one and a half inches by one inch when fully stretched, in the average case at least, and was sutured as tightly as possible to the lumbo-dorsal aponeurosis and underlying muscle, with minimal dead space between. Linen thread was used for stitching, and the embedded graft was prepared only by removal of all fat from the under surface, and by careful clipping away of hair, avoiding trauma to the epidermis. Before closing the incision, a film of sulphonamide powder was insufflated over the operation area, and the skin closed by continuous linen suture.

A second series of 10 rabbits were dealt with in the same fashion, excepting that here, a coating of hair approximately two to three millimetres long was permitted to remain on the graft. This was left as a deliberate challenge to Nature, and the results were studied in the same way as those of the first series.

Microphotographs are appended to illustrate the various changes which were observed to take place, and a report accompanies each illustration.

REPORTS ON THE SECTIONS OF WHOLE SKIN IMPLANTS WITH PHOTOGRAPHS.

As there was but little difference between the findings of the two series of cases where the grafts were free of hair, and where a fine coating remained, the reports are considered together, chronologically from early post-operative days up to a period nine months later.

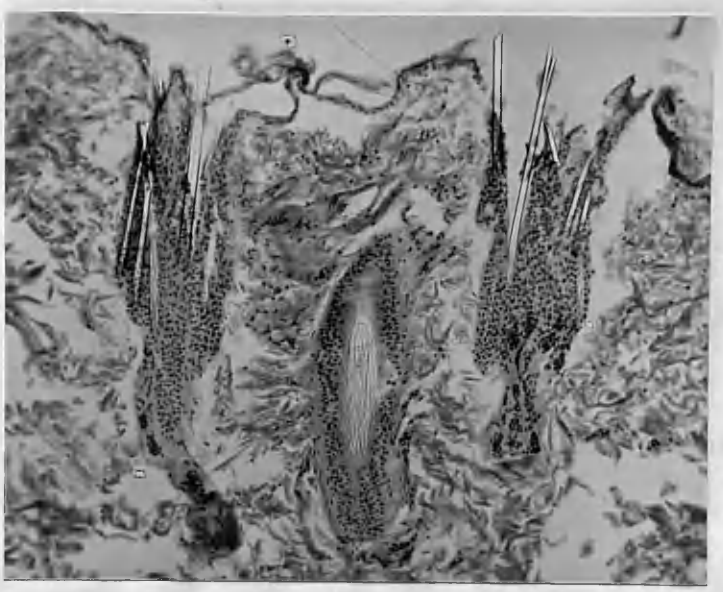


Figure 28 X 75.

Section through normal rabbit skin stained by Haematoxylin and Eosin.

Report.

The field demonstrates a thin layer of epidermis with several hair follicles containing short cut hairs. The follicles are seen to penetrate deeply into the dermis which has a scanty cellular content held within a mesh of fibrous bundles.

The epidermis varies, apart from hair follicles, from two to four cells deep, and no definite strata can be detected other than the stratum corneum and the basal layer. No sweat or sebaceous glands are seen in this field, but hair roots and bulbs are well demonstrated.

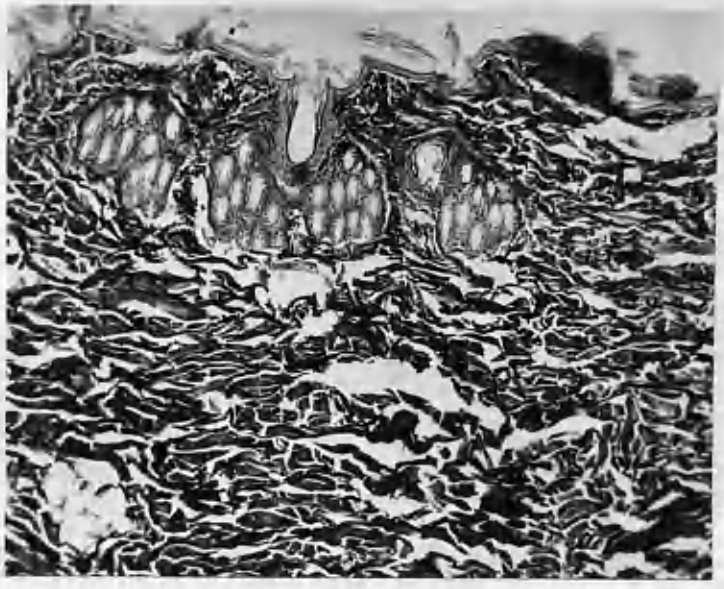


Figure 29 X 75.

Section through normal rabbit skin stained by Van Giesen's reagent.

Report.

This slide demonstrates collagen bundles of the normal dermis supporting a few cells. There are numerous hair follicles and glands seen on transverse section. The epidermis is shown as a thin layer of ovoid or round cells with no definite basement membrane.

Figure 30 X 75.

Rabbit 15. Slide 15. Graft implanted for one day. Stained by haematoxylin and Biebrich.

Report.

The superficial fibres of the dermis are pale and somewhat ischaemic, yet there are considerable numbers of blood vessels in the dermis. The stratum cornium of the epidermis is readily seen, and is partly desquammating. There is some generalised increase in the cellular content of the dermis, but the cells do not appear to derive from a reaction between the muscle and the graft itself. It is more probable that they are part of an early inflammatory process and have migrated from the vessels by diapedesis.
Hair follicles are present in transverse section and seem normal.

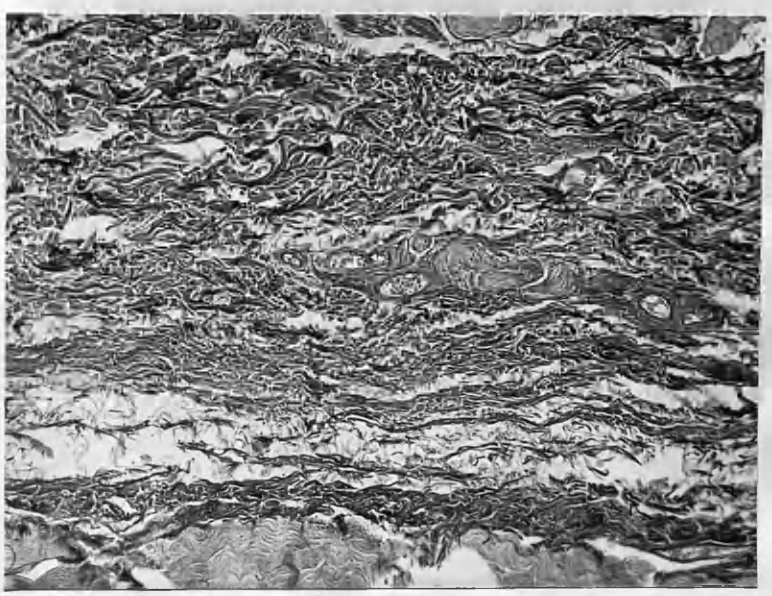


Figure 30 a. X 100.

Rabbit number 5. Slide number 3438/6/. Graft implanted for one day. Stained by Weigert and Van Giesen's methods.

Report.

This section is stained to demonstrate collagen and elastic tissue. The elastic fibres are normal in appearances and supported by a cellular dermis. There is no reaction between the graft and underlying muscle at this stage.

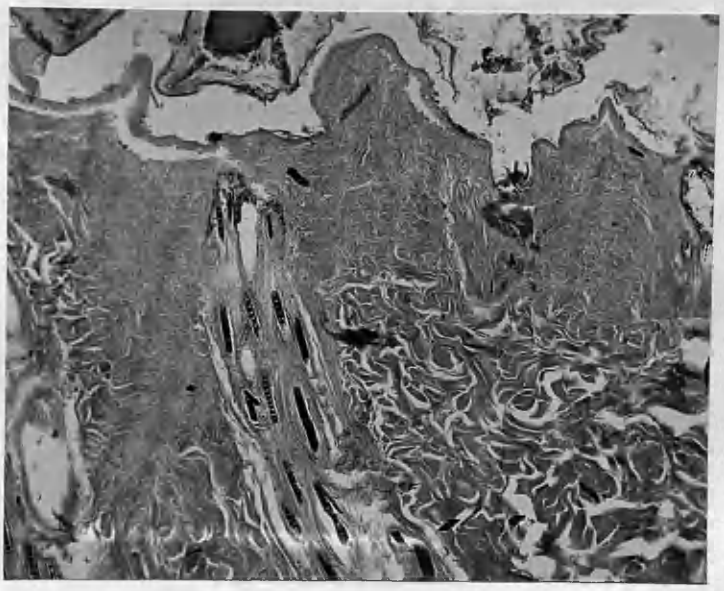


Figure 31 X 75.

Rabbit 31. Slide number 44. Graft implanted for three days. Stained by Haematoxylin and Biebrich.

Report.

The field shows necrosed epidermis with desquammation of epithelium, the debris lying on the surface of the graft. On the surface there are also clumps of bacteria. The infection does not appear to be acute. Hair follicles are well shown and both they and their contained hairs show evidence of atrophy. Outwith the limits of the present field there is evidence of aseptic necrosis of the deeper fibrous bundles of the dermis, which is being invaded from its deep aspect by a cellular reaction between the graft and the muscle.

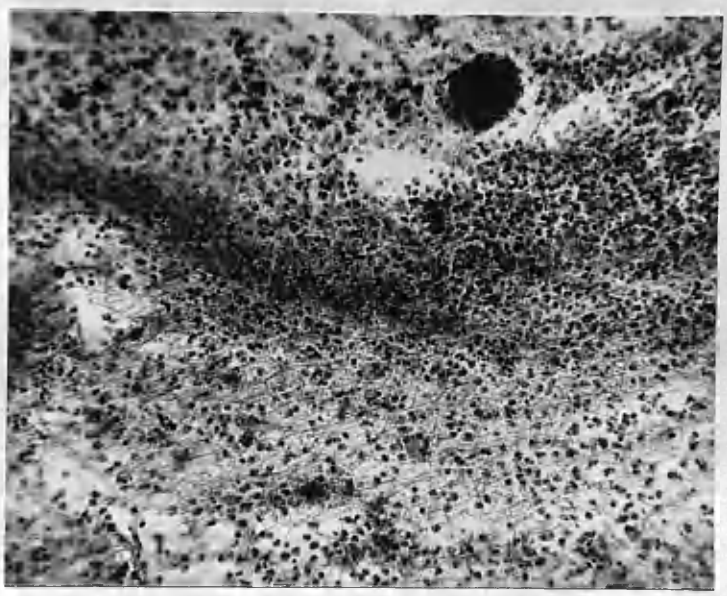


Figure 32 X 225.

Rabbit 30. Slide 42. Graft implanted for 3 days.

Stained by Haematoxylin and Biebrich.

Report.

Section through the surface of the graft under high power, to demonstrate the nature of the cellular reaction and necrosis which takes place after implantation under tension.

There is an accumulation of dead cells and epithelial debris with infection. Clusters of organisms are seen and also several small abscesses. Polymorphonuclear leucocytes predominate in the cell exudate.

Viewing this section as a whole it can be shown that the dermis is healthy and that the necrosis is confined to the superficial areas of the graft, involving only the epidermis.

This tissue was, like all others examined, removed from the living animal and placed immediately into fixative.

Figure 33 X 75.

Rabbit Number 31. Slide number 43. Graft implanted for three days. Stained by Van Giesen's connective tissue stain.

Report.

The field demonstrates a section through the middle of the graft in the superficial layers of the dermis. Numerous collagen fibres unaffected by cellular infiltrate are shown. Embedded within them are many hair follicles containing portions of hair.

Outwith this field, though in the same section, the epidermis is in a state of necrosis and is being desquammated on to the surface of the graft. The epidermis has been largely removed in its superficial aspect.

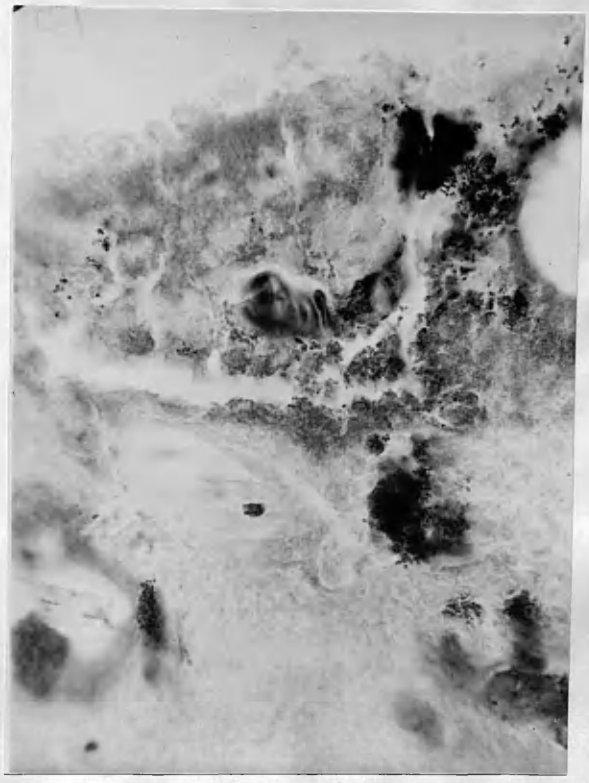


Figure 33 a. X 900.

Rabbit number 31. Slide number 44. Graft has been implanted for 3 days. Stained by Grams Method.

Report.

Clusters of organisms are seen which consist mainly of Gram positive cocci. There are several minute abscesses. The reaction is most apparant at the margin of the graft on its deep aspect.

Figure 33 b. X 900.

Rabbit number 30. Slide number 42. Graft implanted for three days. Stained by Grams Method.

Report.

This section shows numerous clusters of Gram positive cocci forming minute abscesses on the deep aspect of the graft.

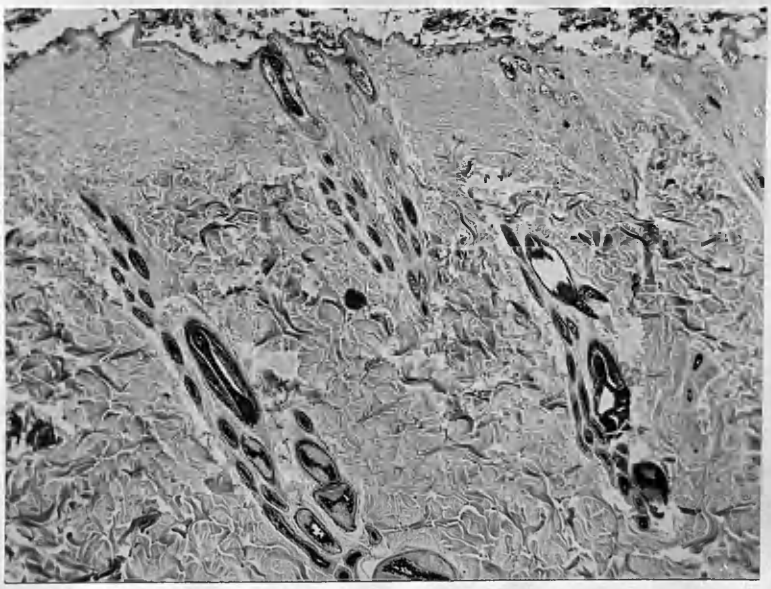


Figure 33 c. X 50.

Rabbit number 31. Slide number 44/1/. Stained by Haematoxylin and eosin. Graft imbedded for three days.

Report.

The section is similar to that of Figure 33, but shows the surface of the epidermis with also most of the dermis. Desquammation of the epidermis has commenced.

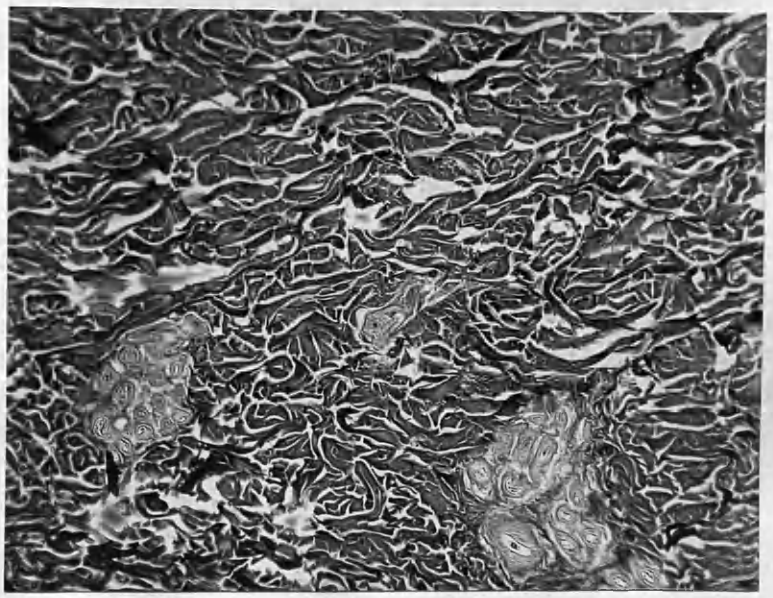


Figure 33 d. X 75.

Rabbit number 31. Slide number 44/4/. Stained by Weigert and Van Geisen's stain. Graft implanted for three days.

Report.

This section is stained to show collagen fibres in the dermis with related torn elastic bundles. Several areas of glandular tissue are seen in relation to hair follicles in transverse section. Elastic tissue degenerates early after implantation.

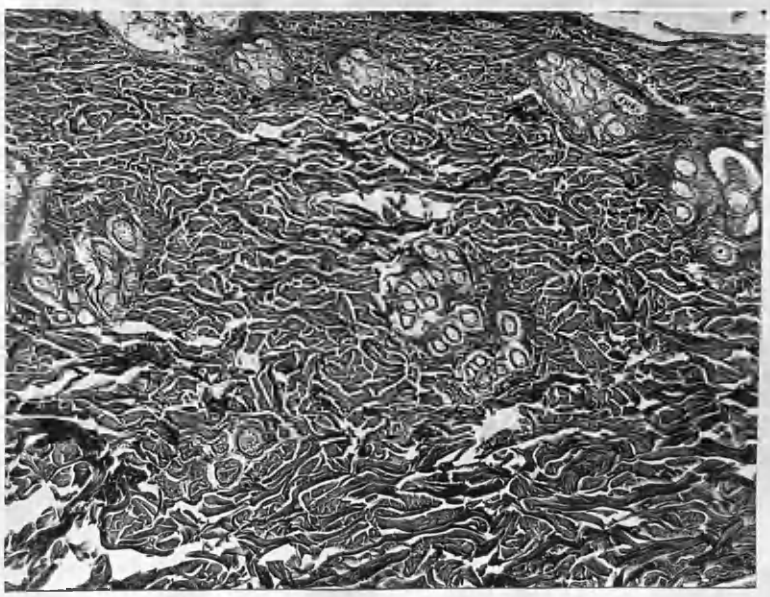


Figure 33 e. X 75.

Rabbit number 31. Slide number 44/2/. Stained by Mallory's method. Graft implanted for three days.

Report.

This section shows findings similar to those of Figure 33 d, save for the absence here of elastic tissue which is not demonstrated by this stain.

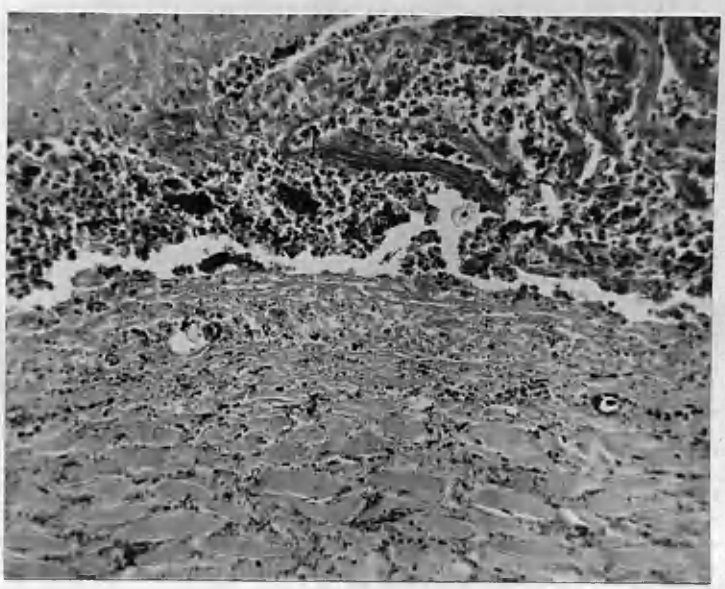


Figure 34 X 225.

Rabbit number 7. Slide number 17. Graft implanted for seven days. Stained Haematoxylin and Biebrich.

Report.

An inflammatory reaction is taking place in the areas between the graft, in the upper half of the field, and its muscle bed. Clusters of bacilli are noted in this field and in others of the same section. ~~Figure , page , shows the same specimen stained by Gramm's method.~~

In addition there are numerous polymorphonuclear leucocytes, lymphocytes and phagocytes in the exudate, which has penetrated the deep aspect of the dermis, and superficial aspect of the subjacent muscle.

Figure 34 a. X 150.

Rabbit number 6. Slide number 3441/4/. Graft implanted for seven days. Staimed by Weigert and Van Giesen's methods.

Report.

Collagen bundles support a cellular infiltrate. The elastic tissue is scanty and degenerate. There is some necrosis of the graft is both its superficial and deep aspects.

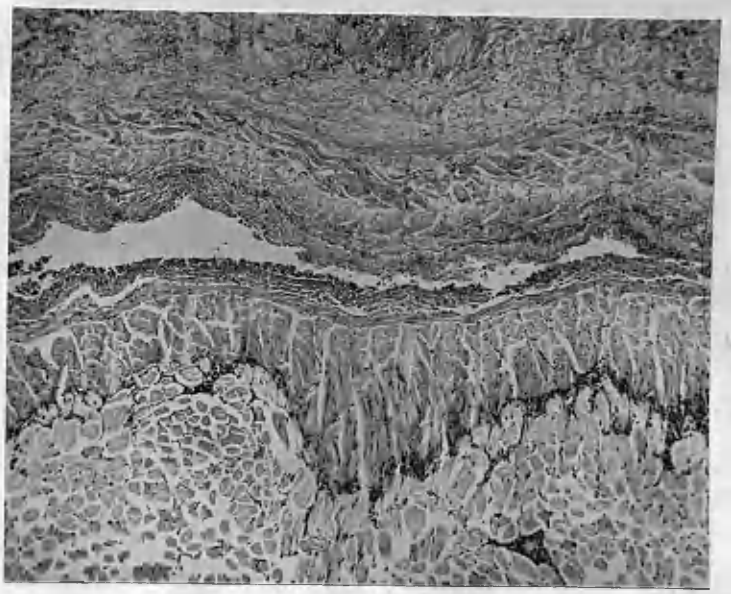


Figure 35 X 75.

Rabbit number 6. Slide number 16. Graft implanted for seven days.

Stained by Haematoxylin and Biebrich.

Report.

This field shows the graft superimposed upon muscle after having been implanted for seven days. In cutting the section, some separation has taken place, showing that union at the end of a week is not firm.
A cellular reaction, however, is taking place, which, in the above field and others of the same section, can be seen invading both dermis and muscle.
The section outwith this field shows areas of necrotic epidermis with also, partial necrosis of some of the superficial fibres of the dermis proper. Hair follicles likewise are atrophic, whilst one or two minute abscesses are seen in the superficial layers of the dermis. These are not yet localised, and some giant cells relate to them.

Figure 36. X 160.

Rabbit number 3. Slide number 13. Graft implanted for ten days.

Stained by Haematoxylin and Biebrich.

Report.

The junction of graft with muscle is identifiable, but it is noteworthy that in this specimen, there is comparatively little cellular exudate, and both dermis and muscle show substantially less cellular infiltration than is usual at this date, ten days.
The epidermis has been shed and little remains on the surface of the graft to indicate the cellular activity and phagocytosis which has earlier taken place. Old and new blood vessels are seen. The superficial layers of the dermis are less cellular than the deep, and exhibit evidence of some necrosis. Hair follicles in general are difficult to identify.

Figure 37 X 75.

Rabbit 29. Slide 41. Graft implanted for eleven days. Stained by Haematoxylin and Biebrich's reagent.

Report.

This field exhibits fibrous tissue, a cellular infiltrate and new blood vessels. The dermis is being permeated by granulation tissue.

Viewing this section as a whole and outwith the present field it can be shown that the surface of the graft involving the epidermis is necrotic, as in Figures 31 , 32 , and 33c , and that this necrotic surface shows clusters of bacteria and a few minute abscesses. Between the graft and the muscle is early granulation tissue uniting the one to the other.

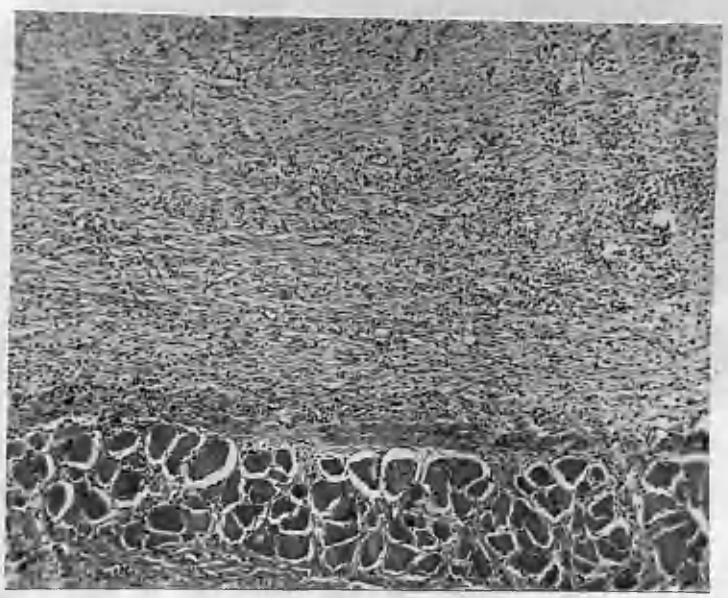


Figure 38 x 75.

Rabbit number 28. Slide number 40. Graft implanted for sleven days.

Stained by Haematoxylin and Biebrich's reagent.

Report.

This field shows clearly the cellular reaction which takes place between the muscle layer and the inferior aspect of the superimposed graft. This cellular exudate is seen infiltrating both the dermis and the subjacent muscle. There is an associated formation of new blood vessels in other parts of the section, and on the surface of the graft the epidermis is necrotic and desquammating. Some hair fragments remain on the surface but destruction of the epidermis is almost complete.

NOTE. Some other sections at a later date show less intense cellular reaction. The reason for these individual variations, which are at times considerable are discussed in the text.

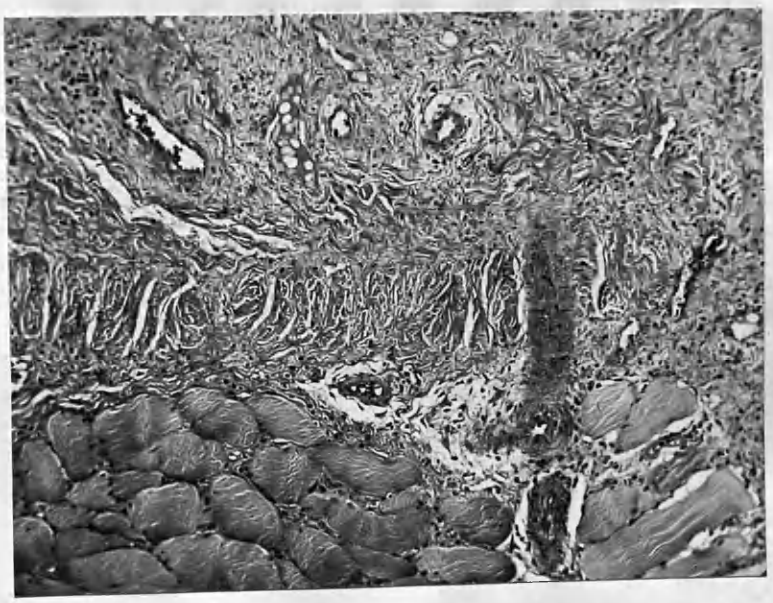


Figure 38 a. X 100.

Rabbit number 29. Slide number 7203/1/. Graft implanted for 11 days

Stained by Haematoxylin and Eosin.

Report.

Cellular young connective tissue is infiltrating between the graft (above) and muscle (below). This infiltrate has penetrated between the muscle fibres and established connection with the perimyseum.

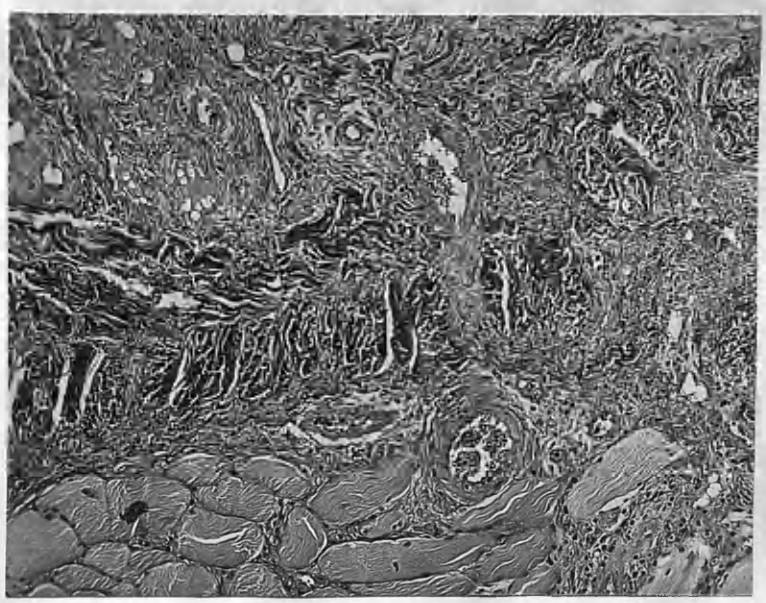


Figure 38 b. X 100.

Rabbit number 29. Slide number 7203/4/. Graft implanted for 11 days. Stained by Weigert's and Van Geisen's methods.

Report.

The report is that of the section exhibited in Figure 38 a but stained to show collagen and elastic tissue. The elastic fibres are not well demonstrated, but what is present is in a condition of degeneration. There is adhesion between the graft and muscle.

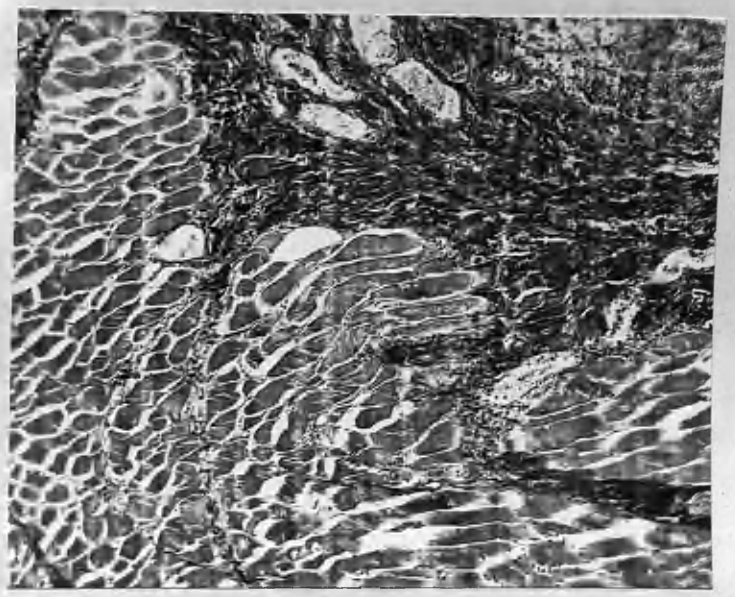


Figure 39 X 75.

Rabbit number 2. Slide 11. Graft implanted for twelve days. Stained by Van Giesen's connective tissue stain.

Report.

Section through the margin of the graft and muscle. The graft is in the upper right half of the field. A delicate cellular reticulum is seen invading the muscle bundles from the area of the graft. The dermis is cellular and new vessels are seen both in this field and in others of the same section.

Outwith the present field, hair follicles persist in a condition of atrophy, but the epidermis has largely been shed, and what remains is necrotic, though apparently uninfected. Union by granulation tissue is demonstrated at all areas between the graft and the muscle.

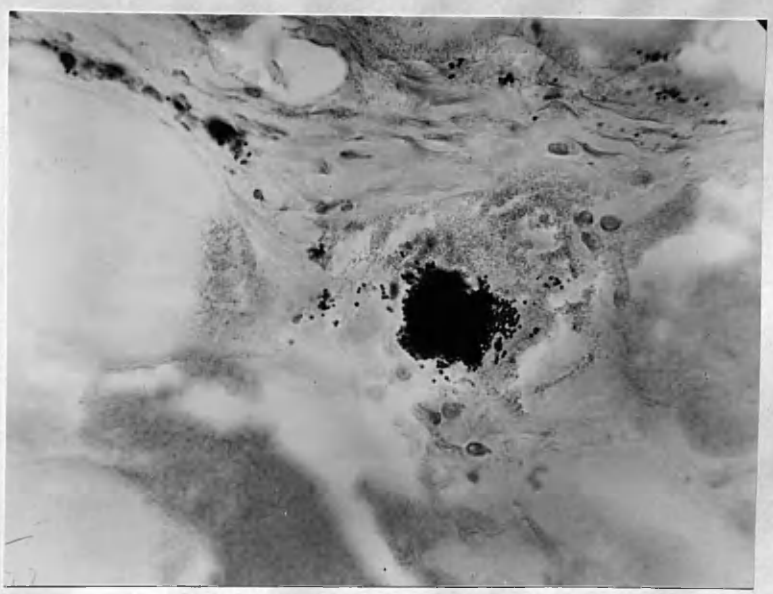


Figure 39 a. X 900.

Rabbit number 2. Slide number 11. Stained by Gram's method.

Report.

This section shows numerous small clusters of Gram positive cocci and one minute abscess. These are situated on the deep aspect of the graft.

Figure 40 X 50.

Rabbit number 2. Stained by haematoxylin and eosin.

Graft implanted for 14 days.

Report.

This graft has been implanted for fourteen days, and this field shows muscle in the bottom right hand corner, with the graft occupying the remainder of the area.
Dead epidermis is clearly demonstrated on the top left hand corner, and the necrosis has extended to affect the superficial layers of the dermis itself. In this small area are clumps of bacteria. Desquammated epidermal tissue with several hair fragments occupy the middle third of the surface of the graft. It can also be recognised that no epidermis is present apart from the necrotic area and this debris.
A rich cellular exudate has infiltrated into the dermis, and there is abundant formation of new blood vessels. This cellular exudate is also identifiable between the muscle bundles and between individual muscle fibres. Fibroblasts are observed in this cellular infiltrate which has permeated all aspects of the dermis and invaded its fibrous stroma. Under high power magnification of this section a layer of fibrin can also be detected between the graft and the muscle at all areas.

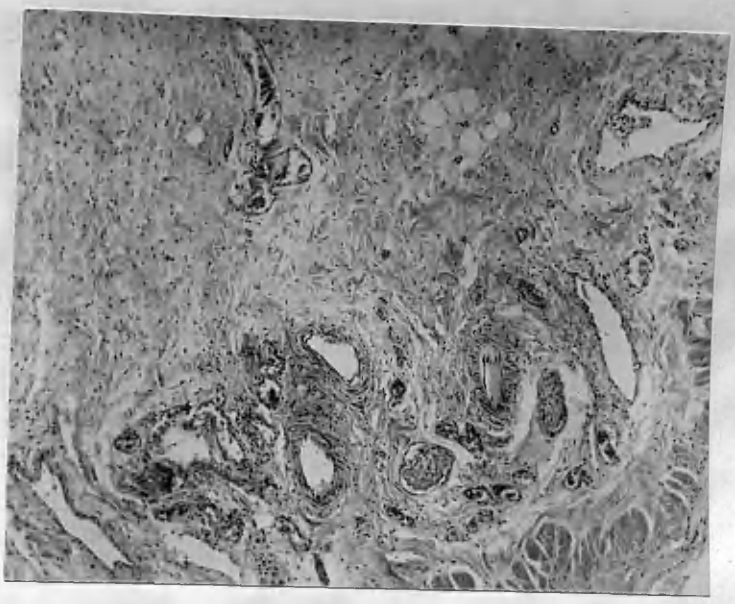


Figure 41 X 50.

Rabbit 1. Slide number 9. Graft implanted for fifteen days.

Stained by Haematoxylin and Biebrich's reagent.

Report.

The above field, and this section as a whole both show abundant formation of new blood vessels embedded in a cellular dermis. At least one nerve is seen. There are numerous fibroblasts and connective tissue cells and some young vessels whose walls are but one cell layer thick.
On examination of other layers of this section there is seen to be an increased degree of cellularity from deep to superficial.
The epidermis is necrotic and in process of being cast off and phagocytosed.

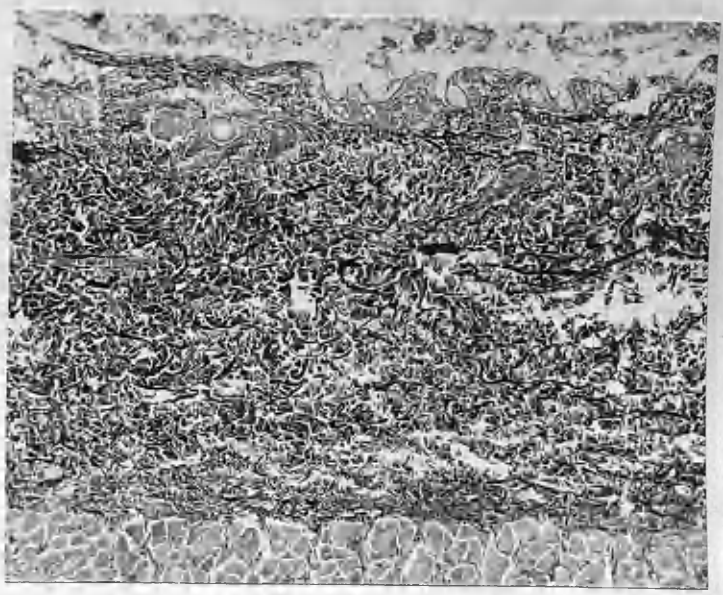


Figure 42 X 45.

Rabbit number 4. Slide number 14. Graft implanted for twenty one days.

Stained by Van Giesen's connective tissue stain.

Report.

Section through the whole thickness of a graft which has been embedded for 21 days. Cellular infiltration of the dermis and prolongation of this exudate deeply between the bundles of muscle fibres are well demonstrated. The epidermis is being desquammated and is necrotic. Hair follicles and sebacious glands persist. The cellular reaction is less intense than in some other sections taken at an earlier stage.

No signs of infection are seen, even on the surface.

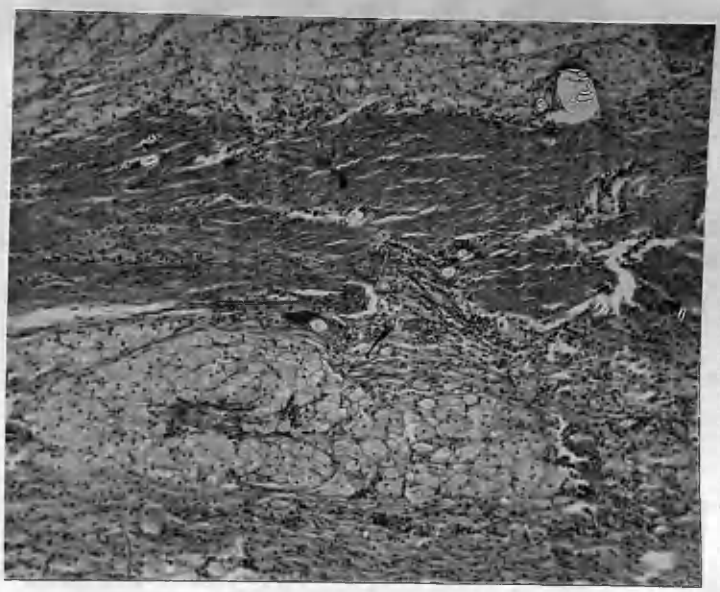


Figure 43 X 75.

Rabbit number 33. Slide 47. Stained Haematoxylin and Biebrich. Graft implanted for thirty days.

Report.

This field demonstrates numerous foamy cells in relation to the deep surface of the graft. A few small hair particles can also be identified. There are, outwith this field, but in the same section, several minute foci of necrosis which are incompletely encapsulated by fibrous tissue young in type. Close to these foci can be seen several giant cells.
These necrotic areas relate to the deep surface of the epidermis but also invade the superficial aspect of the dermis. They seem to arise from a subacute degree of infection not sufficiently intense to cause widespread sepsis. Traces of such a process can be identified in other sections up to as late as six months but then appear to be quite inactive and well localised. Foamy cells relate to them, although they are also found apart from such areas. Round cell infiltration is characteristic of these foci, especially in the early phases of development.
In this section no epidermal cells can be seen, other than the hair fragments indicated above.

Figure 44 X 75.

Rabbit number 32. Slide number 46. Implanted for seventy four days.
Stained by Haematoxylin and Biebrich's reagent.

Report.

In this section no elements can be identified as deriving from epidermis. Healthy fibrous tissue is seen over the site of the graft which contains numerous new blood vessels. A nerve is seen near the bottom of the field. No hairs are observed in the present field.
One part of the section not shown here contains a minute abscess which is apparently well localised and entirely inactive. It is surrounded by fibrous tissue and near it are a few giant cells with characteristics similar to those of Figure 43. Some foamy cells are seen relating to the area.

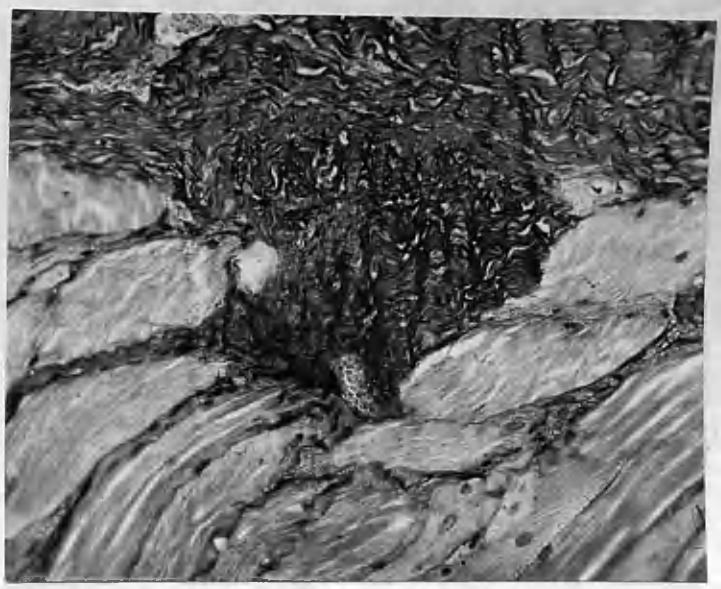


Figure 45 X 225.

Rabbit number 14. Slide number 24. Graft implanted for seventy eight days.
Stained by Van Giesen's reagent.

Report.

The section demonstrates the union of the graft with subjacent muscle. Tentacles of fibrous tissue permeate the muscle from the dermis of the graft, to effect union with the fibrous tissue sheaths surrounding the bundles of muscle fibres. A few blood vessels are seen and the usual connective tissue cells, but no hairs or epidermal elements.

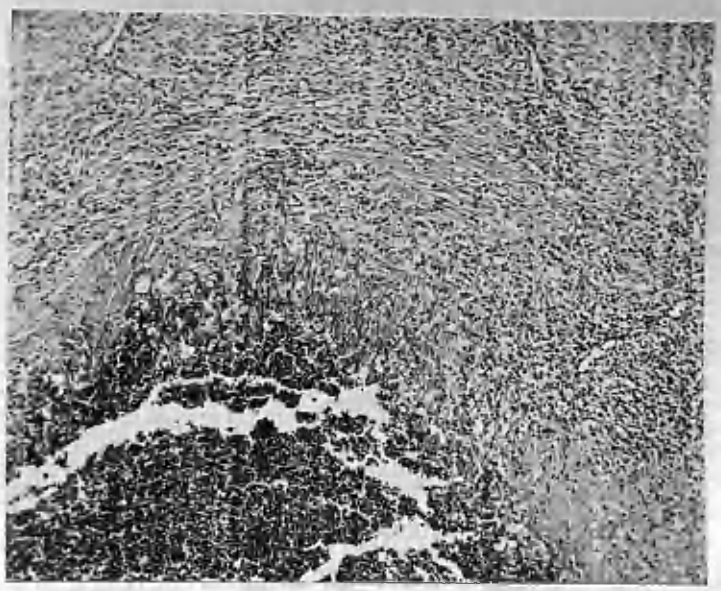


Figure 46 X 75.

Rabbit number 11. Slide number 21. Graft implanted for 78 days. Stained by Haematoxylin and Biebrich's reagent.

Report.

The graft, which occupies the entire field, is still cellular though implanted for 78 days. A small focus of infection is included in the section and its margin shown in the lower half of the field. At the margin of this small abscess certain cells can be seen which have features resembling the formed and typical foamy cells shown in other sections elsewhere. These cells may be transitional forms, though their origin is not obvious.
Collagen bundles persist, but support a dense mass of cells and young fibrous tissue. This field is quite avascular. Polymorphs and lymphocytes predominate in the necrotic area.

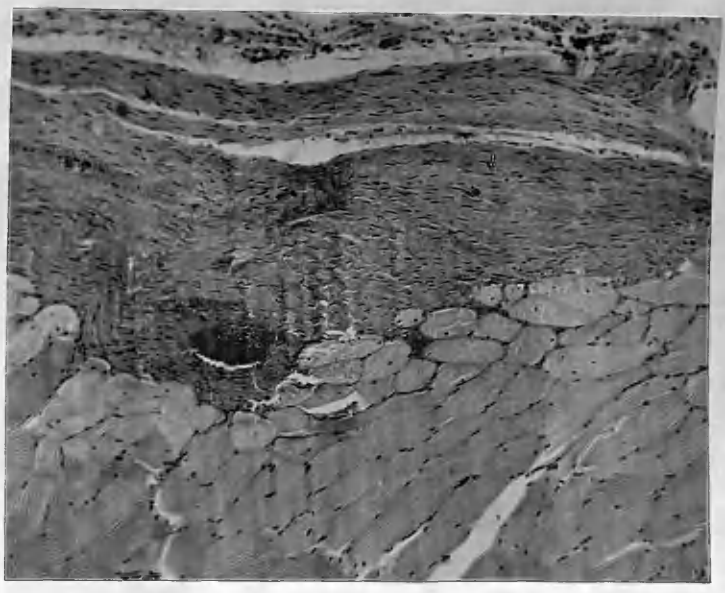


Figure 47 X 75.

Rabbit number 13. Slide number 23. Stained by Haematoxylin and Biebrich. Graft implanted for seventy eight days.

Report.

Fibrous tissue is seen in the upper half of this field, and is overlying skeletal muscle. Union between the two has been effected by means of fibrous strands extending between the bundles of muscle fibres from the adjacent graft. An inflammatory reaction has taken place in the deep aspect of the graft, and traces of its existance remain. This field is relatively avascular, but the section as a whole demonstrates numerous blood vessels and especially on the superficial aspect of the graft. No epidermal elements are identified.

Figure 48 X 225.

Rabbit number 17. Slide number 27. Graft implanted for one hundred and twelve days.
Stained by Van Giesen's connective tissue stain.

Report.

Section through the margin of graft with adjacent muscle. The graft is in the upper half of the field. This section has been cut very thin, and demonstrates a delicate reticulum of fibrous tissue interlacing between the collagen bundles above and the muscle fibres below. Viewed as a whole and outwith the limits of the present field, the section shows that the graft has been converted to stout fibrous tissue within which no epidermal or hair elements can be identified. The graft is less cellular than during the first three months after inlay, and no foamy or giant cells are shown. The graft is well vascularised, but less intensely so than earlier specimens. A few encapsulated areas contain flattened cells of doubtful origin, possibly old abscesses.

Figure 49 X 75.

Rabbit number 18. Slide number 28. Graft 112 days implanted.
Stained Haematoxylin and Biebrich.

Report.

This field is part of a section through a graft which has been implanted for 112 days. It demonstrates young cellular fibrous tissue. Numerous fibroblasts and connective tissue cells are supported in a matrix of collagen fibres. There are few giant cells or foamy cells in this section. A few minute fragments of hairs are present in other areas.

In both the superficial and deep aspects of the graft there are numerous blood vessels, though the above field is somewhat avascular.

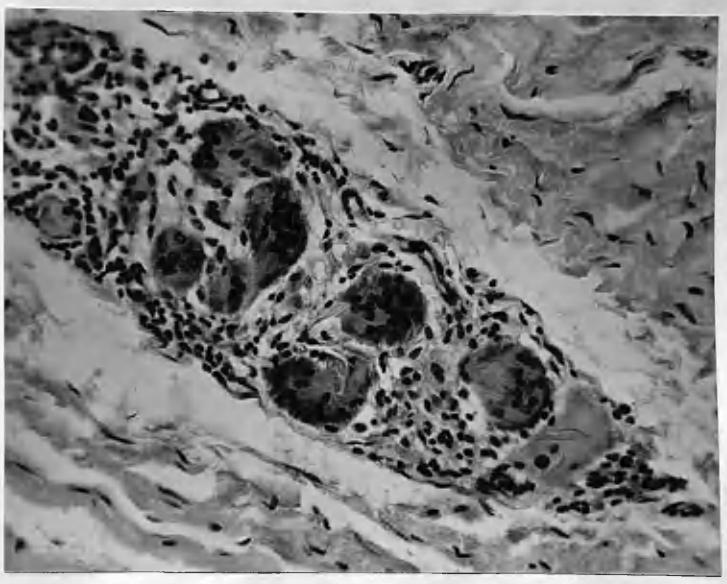


Figure 50 a. X 450.

Rabbit number 16. Slide number 26. Graft implanted for 112 days. Stained by Haematoxylin and Biebrich.

Report.

The giant cells mentioned in the ~~previous~~ next report are shown under high magnification.

Figure 50 X 75.

Rabbit number 16. Slide number 26. Stained Haematoxylin and Biebrich. Graft implanted for 112 days.

Report

This field shows the margin of the graft relating to numerous foamy cells and hair remains. In the section, giant cells are numerous, though scanty in the present field. These giant cells relate to particles of foreign bodies, probably of linen sutures, and differ from those demonstrated on Figure 55 where the nuclei form a ring around the periphery of the cell. Here they form clusters scattered throughout the cytoplasm, and stain deeply, contrasting with the pale helio of the cytoplasm. These giant cells are well demonstrated on the next figure, Fig. 50a. and under high magnification. Viewed as a whole this section shows a fibrous tissue plaque relating deeply to muscle, and attached to it. No epidermal cells are observed. The present field shows chiefly collagen fibres, hair fragments and foamy cells.

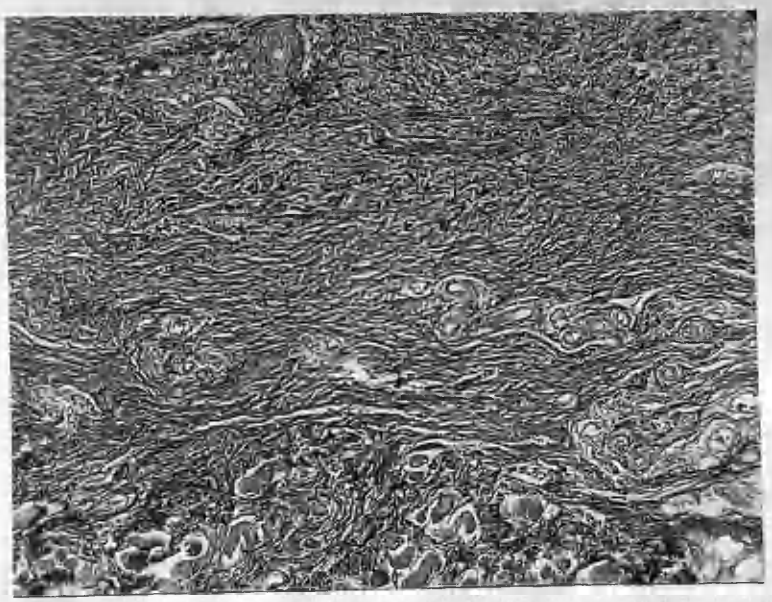


Figure 50 a. X 75.

Rabbit n umber 18. Slide number 6322/9/. Graft inlaid for 112 days. Stained by Mallory's method.

Report.

This section shows cellular fibrous tissue in the upper two thirds of the field. This is firmly united to muscle below.

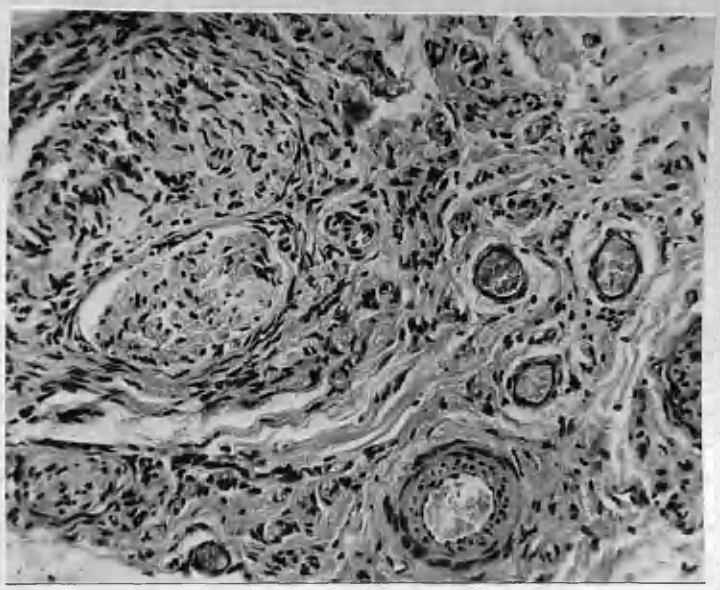


Figure 51 X 225.

Rabbit 16. Slide number 26. Stained Haematoxylin and Biebrich. Graft implanted for 112 days.

Report.

This section shows two encapsuled areas containing flattened and somewhat cornified looking cells, surrounded by a capsule of fibrous tissue and relating to several blood vessels. Whether these cells are minute collections of cornified epithelium derived from the epidermis, or a late stage in a previous small focus of infection is open to doubt, but I incline to the former view. In all sections of tissue examined during these investigations no other examples of this type of cell formation were seen.

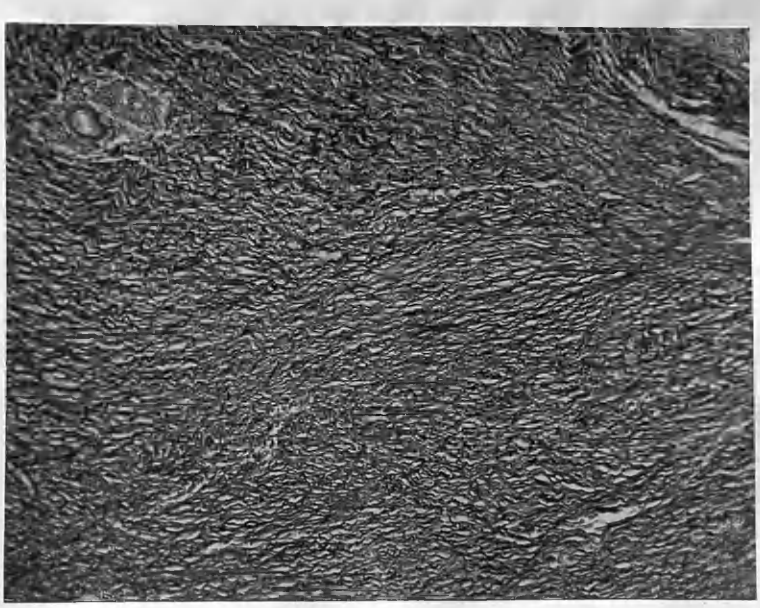


Figure 51 a. X 75.

Rabbit number 18. Slide number 28/6/. Graft implanted for 112 days. Stained by Weigert and Van Giesen's stains.

Report.

The section shows fibrous tissue and blood vessels only. The site of union between the graft and muscle is not demonstrated, only the graft being in the present field.

Figure 52 X 75.

Rabbit 25. Slide number 35. Graft implanted for 139 days. Stained by Haematoxylin and Biebrich's reagent.

Report.

The section demonstrates young scar tissue which is less cellular than in earlier phases of development. As this graft has been dissected from the surface of its attachment, little muscle can be seen at any area, when the section is viewed as a whole. The above field shows young, and fairly cellular scar tissue in which there is an entire absence of epidermal cells. A few fragments of hair can be seen however, and again it is notable that they have provoked no foreign body reaction, and that there are no related giant cells. This particular graft was inlaid with a fine covering of hair. It is interesting to observe that the graft 'took' satisfactorily, and that on histological examination, there are few signs to indicate its original nature, or hairy coat.
In the present field are numerous foamy cells. The origin of these cells remains obscure at present. It is interesting that they are not observed in early sections, only after implantation for a minimum period of 3 weeks.

Figure 53 X 75.

Rabbit number 8. Slide number 18. Implanted for 139 days.
Stained by Haematoxylin and Biebrich's reagent.

Report.

This section through a graft which has been embedded for 139 days shows firm fibrous tissue at all areas, this being less cellular than at two to three months. No hairs or other epidermal elements are seen. Viewed as a whole, outwith this field it is seen that the graft has been well vascularised.

Figure 54 X 75.

Rabbit number 9. Slide number 19. Implanted 140 days. Stained by Haematoxylin and Biebrich's reagent.

Report.

The graft in this section has been converted into or replaced by, fibrous tissue, and in this no epidermal elements can be identified. There are, however, three small abscesses which are well encapsulated. Two are present in this field. They show some central necrosis with clusters of bacteria and connective tissue cells, polymorphs, and round cells. Numerous giant cells are also seen, some of which are shown in Figure 55, page 358 under high magnification.

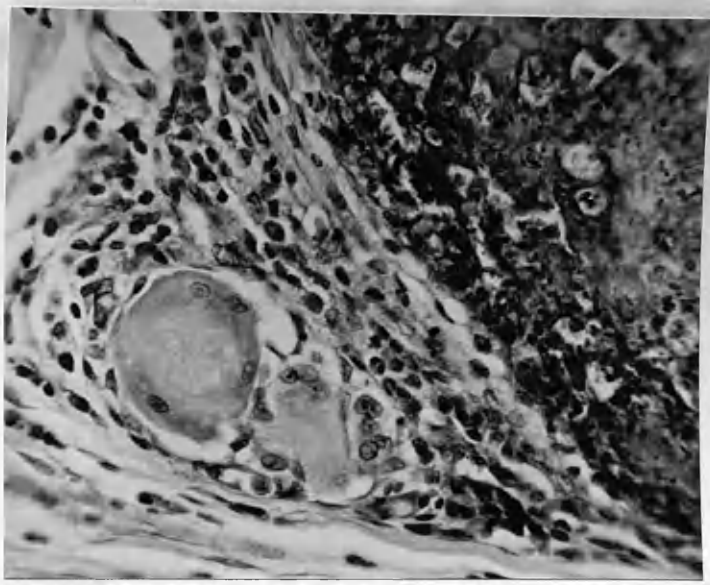


Figure 55 X 450.

Rabbit number 9. Slide number 19. Implanted 140 days. Stained by Haematoxylin and Biebrich.

Report.

Two giant cells are demonstrated lying at the margin of a minute focus of infection, though definitely outwith it. These are typical of other giant cells seen in other sections studied during this work. They are large, round or ovoid, have clear cytoplasm containing fine granules and stain a characteristic helio with H. and B. reagent. They have many nuclei up to ten or more, arranged in a ring around the periphery of the cell. The nuclei stain deeply and contain at least one nucleolus.
The cells are always located near a focus of infection and have not been demonstrated in relation to hairs or other foreign bodies.

Figure 56 X 75.

Rabbit number 10. Slide number 20. Implanted for 140 days.
Stained by Van Giesen's method.

Report.

This field shows dense fibrous tissue in the upper right half, and attaching to adjacent muscle by prolongations which unite with the fibrous tissue surrounding the muscle bundles. This section was very hard and tended to fragment on cutting, and is not the best example of its kind, but does show clearly the density of the fibrous tissue of the graft. No epidermal tissue can be identified either in this field or in the section as a whole other than a very few minute fragmented hairs.
This particular field is chosen to demonstrate again the presence of foamy cells, and this time in relation to the margin of the graft, but located outwith it. These cells, with this stain, have a clear, pale brown cytoplasm containing a small round eccentric dark staining nucleus.

Figure 57. X 225.

Rabbit number 26. Slide 37. Implanted 166 days. Stained by Van Giesen's reagent.

Report.

The foamy cells mentioned in relation to Figure 56 are well shown under higher magnification. They are large and have a small eccentric nucleus, often located at the periphery of the cell. They are found in clusters presenting a honeycomb appearance on section. There are definite cell membranes and the cytoplasm is finely granular though sometimes containing a clear area like a vacuole. These cells are embedded in a fine connective tissue stroma containing a few blood vessels. Several small hair fragments are seen in the upper half of the field.

Figure 58 X 75.

Rabbit number 26. Slide number 37. Implanted for 166 days.
Stained by Van Giesen's connective tissue stain.

Report.

This section demonstrates fibrous tissue containing much old collagen, and supporting numerous cells including giant cells and hair fragments. Foamy cells are well seen in this field. The origin of these cells is obscure, but they may derive from degenerated collagen. Their function probably includes phagocytosis. They are well shown under high magnification on Figure 57

Figure 59 X 75.

Rabbit 26. Slide number 38. 166 days.
Stained Haematoxylin and Biebrich.

Report.

This section shows the margin of two small foci of infection containing masses of bacteria, round cells and leucocytes. Fibres of fibrous tissue are disposed around them in a form of capsule; relating to both areas are masses of foamy cells. On the right hand side of the field are a few small necrotic hairs and some blood vessels.
In the section viewed as a whole, and outwith the limits of the present field, the skin graft can be shown to have been converted into a firm fibrous tissue plaque containing its own rich supply of vessels. The two small abscesses shown are the only ones noted in the portion of tissue examined from this graft and are apparently inactive.

Figure 60 X 225.

Rabbit number 19. Slide number 29. Implanted for 199 days.
Stained by Van Giesen's connective tissue stain.

Report.

The graft is seen in the upper left corner of the field. It has been implanted for 199 days, and under high magnification shows union with the adjacent muscle by means of delicate fibrils of collagen and connective tissue penetrating between the muscle bundles from the graft. This section has been cut very thin indeed and the connective tissue reticulum can be shown to unite with the fibrous sheaths round the muscle bundles.

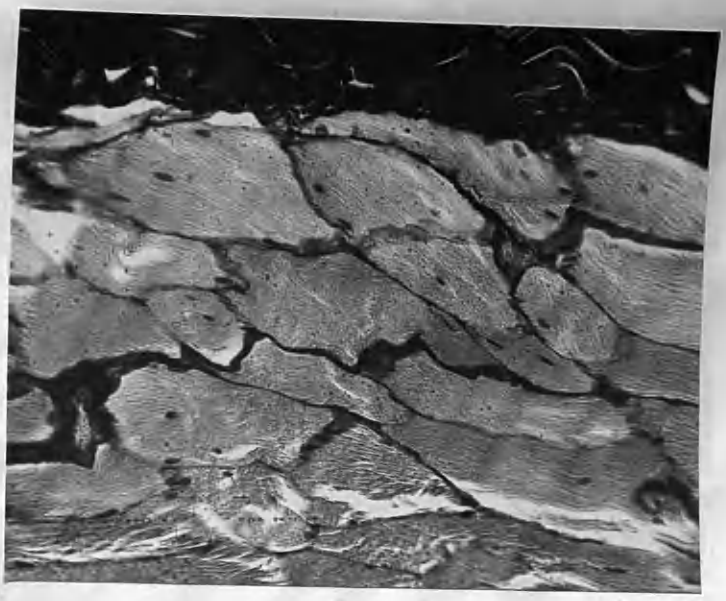


Figure 61 X 225.

Rabbit number 20. Slide number 33. Implanted for 238 days.
Stained by Van Giesen's connective tissue stain.

Report.

High power view of the union between the graft, which has been replaced by firm fibrous tissue, and adjacent muscle upon which it was laid at operation. The graft has been converted into dense collagen and fibrous tissue, and is located in the upper half of the field. It is seen that the graft has united with the fibrous sheaths of the muscle bundles, and that this union is strong. Muscle cells are healthy.

Few signs remain anywhere of the cellular reaction which preceded the union of muscle and graft.

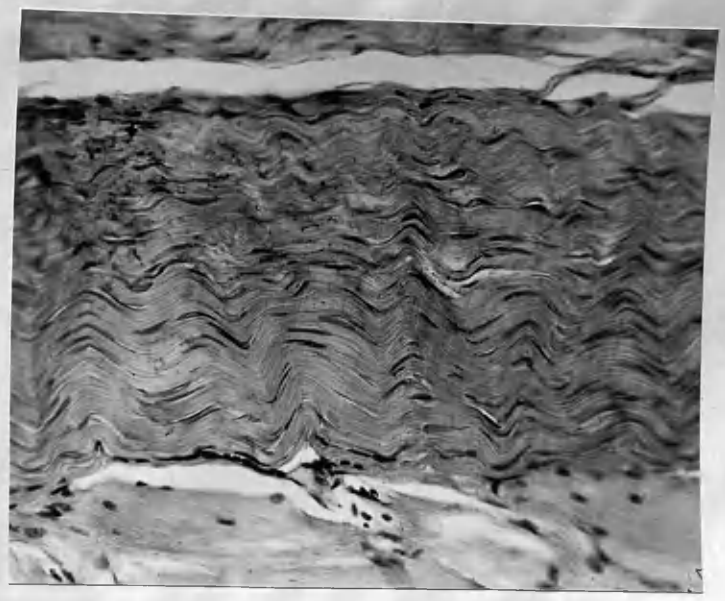


Figure 62 X 225

Rabbit number 22. Slide number 30. 238 days. Stained haematoxylin and Biebrich.

Report.

The field shows organised fibrous tissue which is relatively acellular, and is seen lying on top of muscle to which it has become attached. A blood vessel is seen cut obliquely, and also a lymphatic space.
Neither in the above field or in the section viewed as a whole, can evidence of cells of epidermal origin be detected. There are no infective foci, giant cells or foamy cells, and the graft is represented by firm fibrous tissue which is firmly adherent to its bed of muscle and to its fibrous attachments at the periphery.

Figure 62 a. X 75.

Rabbit number 22. Slide number 30/2/. Graft implanted for 238 days. Stained by Mallory's method.

Report.

This section demonstrates the late union between graft and muscle. The homogenous fibrous tissue of the graft occupies the upper two thirds of the field.

Figure 62 a. X 200.

Rabbit number 22. Slide number 20. Graft implanted for 238 days. Stained by Weigert and Van Giesen's Methods.

Report.

The section shows the junction between the graft above, and muscle below, with hair fragments between. No trace of dermal or epidermal elements are seen.

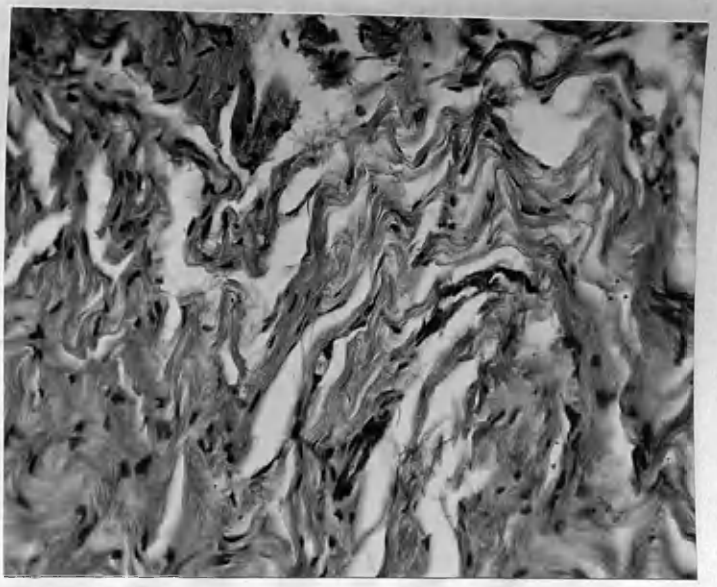


Figure 63 X 225.

Rabbit number 24. Slide number 32. Implanted for 288 days.
Stained Haematoxylin and Biebrich's reagent.

Report.

A characteristic field of this section to demonstrate a mass of collagen fibres. No epidermal elements are seen. Some connective tissue cells are observed and a few blood vessels cut obliquely. No giant cells or hair follicles can be identified.

Figure 64 X 75.

Section through normal guinea pig skin stained by Haematoxylin and Biebrich's stain.

Report.

The field shows the epidermis several layers of cells thick. The stratum corneum is well seen. There are numerous hair follicles on transverse section. The deeper cells of the epidermis are ovoid with eccentric nuclei and granular cytoplasm. The stratum granulosum has flattened cells for the most part, and nuclei which are less dense. The dermis shows bundles of fibrous strands with scanty cellular content, but supporting blood vessels and hair follicles.

Figure 65 X 75.

Section of normal guinea pig skin stained by Van Giesen's reagent.

Report.

The field demonstrates collagen fibres in the dermis, numerous hair follicles and a few blood vessels. The epidermis has been cast at one point, possibly when preparing the section or in cutting the hard block. The dermis is almost acellular.

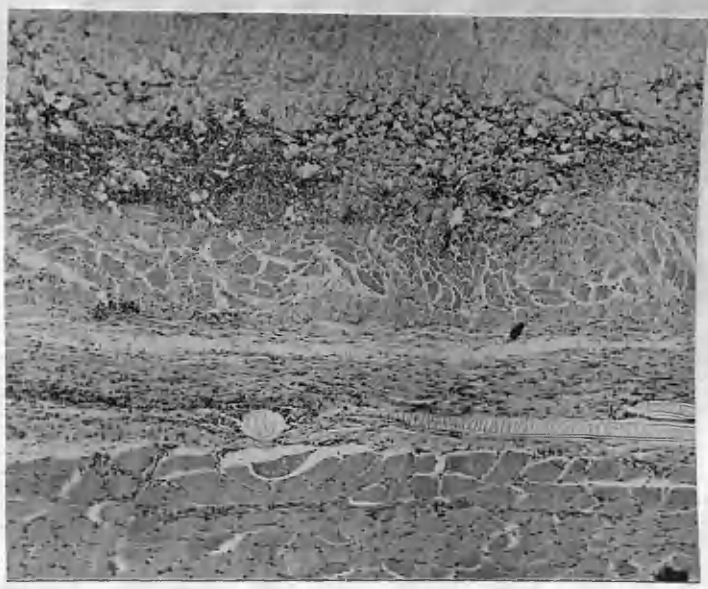


Figure 66 X 50.

Guinea pig number 3. Slide number 4. Implanted 4 days. Stained by Haematoxylin and Biebrich's reagent.

Report.

This field demonstrates the junction of the graft with muscle, and the cellular exudate which forms at that site. This exudate permeates into the dermis, and between the muscle bundles deeply, to give rise to young granulation tissue which later organises to fibrous tissue and makes firm union between the two structures. A hair is seen on coronal and on transverse section. This must be due to accidental contamination of the wound at operation before the graft was superimposed on to the muscle. It is interesting that no giant cells are seen near it or other local sign of irritation. Outwith the present field, the epidermis can be seen desquammating and necrotic. On the exudate covering the graft are numerous polymorpho-nuclear leucocytes.

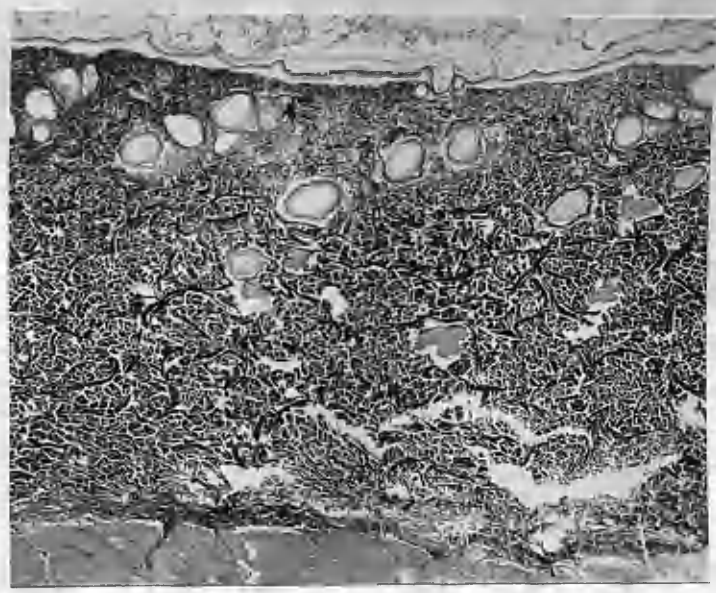


Figure 67 X 45.

Guinea pig number 1. Slide number 3. Implanted five days. Stained Van Giesen's method.

Report.

The epidermis is thin and necrotic. It has largely separated from the true dermis though leaving behind fragments of intradermal papillae and numerous hair follicles. Most of these are seen on transverse section. In the area between the graft and its bed of muscle an inflammatory reaction is in progress. This is better demonstrated under a higher magnification, and also in other parts of the section. The usual debris is observed on the surface of the graft with desquammation of the stratum corneum.

Cellular infiltration of the dermis is less intense than during later phases of the process of union.

Macroscopic Appearances of the graft.

Within 48 hours of implantation the graft is covered by a thin film of milky pultaceous material containing flakes of epidermis. The amount of this exudate increases up to the third week.

By the third week the entire operative area is covered by a layer of this white, pultaceous exudate and there may be some slight swelling of the wound. This fact has been observed clinically in quite a number of cases, when in the second or third post operative week the wound is seen to be swollen, slightly indurated and almost as if there was a low grade infection in progress deeply . This condition lasts for a few days improving slowly, and in only 2 cases of my own has been a cause of sepsis. This reaction is not associated with pain, malaise or elevation of temperature or pulse rate. By the end of the third week it is quiescent and the wound normal.

In the rabbit during the third week similar phenomena are observed. The swelling subsides rapidly however, and by the end of the third week the exudate is less in amount and the graft resembles fibrous tissue more than skin.

At the end of 6 weeks the exudate has disappeared entirely in most cases and the graft appears as a plaque of white tissue firmly adherent to its surroundings.

By the end of three months the graft appears as a

plaque of sound fibrous tissue, vascular and strongly attached to its surroundings. The vascularity diminishes with passage of time and by the end of 6 months the graft macroscopically has the appearances of avascular fibrous tissue. There is little scarring. The margins of the graft are difficult to determine.

HISTOLOGY OF WHOLE SKIN IMPLANTS IN HUMAN SUBJECT REMOVED POST OPERATIVELY.

An opportunity arose to explore an inguinal canal in the human subject, into which a whole skin graft had been sutured for a large direct hernia three months earlier. The patient was an Italian Prisoner of War. The condition had not recurred but the other side required operation for the same condition, and the patient was anxious to have a keloid scar excised which had developed after the first. He did not wish X-radiation to the scar. In addition to removing the scar, the external oblique was opened up from the external ring for two or three inches and the appearance of the graft studied.

It was not possible to determine the exact margins of the graft, so intimately had it fused with the inguinal ligament, medial aponeurotic edge of internal oblique, lower

border insertion of rectus sheath into the upper aspect of the pubis, and the fascia over the anterior aspect of pubis. The repair was entirely satisfactory, and it was conspicuous by the absence of dense fibrosis which is so characteristic a feature of fascial repairs during early stages of healing. The appearances closely approached those of normal. The change into tissue closely resembling that to which the graft had been sutured was striking.

A portion of the superolateral part was removed for histological examination, and sections were stained by Van Gieson's connective tissue stain, and by Haematoxilin and Biebrich.

The histology was that of highly vascular connective tissue in which no dermal or epidermal elements could be identified. The graft was richly infiltrated with collagen and elastic fibres, and there was firm adhesion to the underlying muscle. No trace of even microscopic cyst formation was found, but a number of giant cells were observed. No hair remnants were identified.

Microphotographs of the section are shown, Figures ~~and~~ 68 .

In a second case, a whole skin graft was used to repair a large umbilical hernia in June, 1943. In October, 1944, I removed the gall bladder through a right upper paramedian incision. An opportunity was thus given to

Figure 67 a.

The inguinal canal has been exposed three months after the inlay of a whole skin graft for the repair of a large direct hernia. The graft is identifiable in this monochrome photograph as a dark area overlying the floor of the canal.

Figure 67 b.

The same appearances as in Firgure 67 a, but with the spermatic cord retracted in the opposite direction.

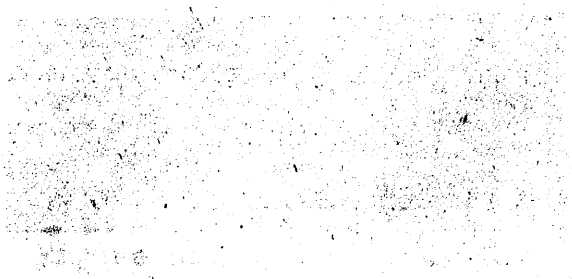
remove a part of the graft sutured to the anterior aspect of the right rectus sheath sixteen months earlier. The area exposed at operation showed clearly that the graft had been converted into stout fibrous tissue and the point where it blended with normal rectus sheath could be determined owing chiefly to the difference in the density of the two areas. The graft was the more vascular. A small portion was removed carefully from the underlying muscle and the gap in the sheath closed.

The section was studied histologically. It showed no trace of former epidermal elements and no giant cell formation. It was less vascular than that graft studied in the third month and consisted mainly of stout fibrous tissue. There was no trace of cyst formation. Fig. 69.

It appears from consideration of the results of the experiments performed that it is safe to implant these whole skin grafts. There is no evidence of epidermoid or inclusion cyst formation, there is no sign of malignant change in the tissues examined, and the skin undergoes a striking transformation into powerful and vascular connective tissue, forming a firm support to the desired area. It establishes an intimate connection with the fascial layers to which it is sutured, and also connects to the underlying muscle as does the conjoined tendon to inguinal ligament under ideal conditions, and as described

by Rosenblatt and Cooksey.

The results found after operation for hernia in the human subject, are detailed in Chapter. 15.



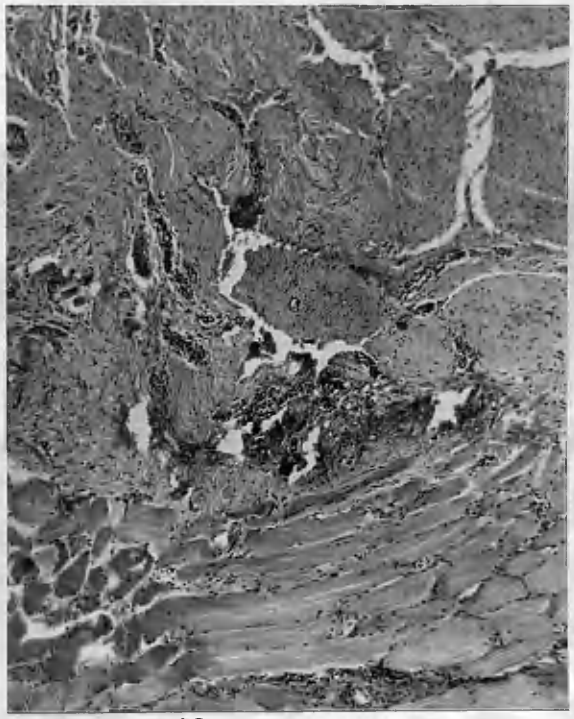


Figure 68 X 50.

Section through a portion of graft inlaid for cure of an inguinal hernia in the human subject, and removed by biopsy three months later.
Stained Haematoxylin and Biebrich.

Report.

The graft is in the upper two thirds of the field, and muscle in the lower. The graft shows organising scar tissue with dense formation of blood vessels. Union with muscle has been made by processes of fibrous tissue, still fairly cellular, penetrating into the muscle from the graft and uniting with the fibrous sheaths round the muscle bundles. Neither in this field or in the remainder of the section can epidermal elements or hairs be identified.

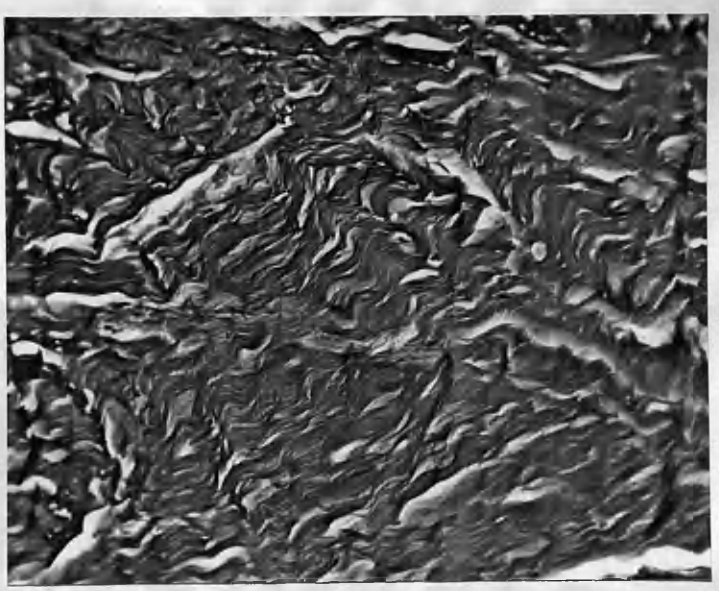


Figure 69 X 225.

Section through a portion of graft embedded into a human subject and removed by biopsy 16 months later. Stained by Van Giesen's reagent.

Report.

The field is typical of the section as a whole, and demonstrates only dense and old fibrous tissue with abundant collagen. There is a scanty cell content, and blood vessels are not numerous. Absolutely no trace of hairs or other epidermal elements could be observed.

Macroscopically the graft resembled stout fibrous tissue closely resembling that of the rectus sheath, or linea alba.

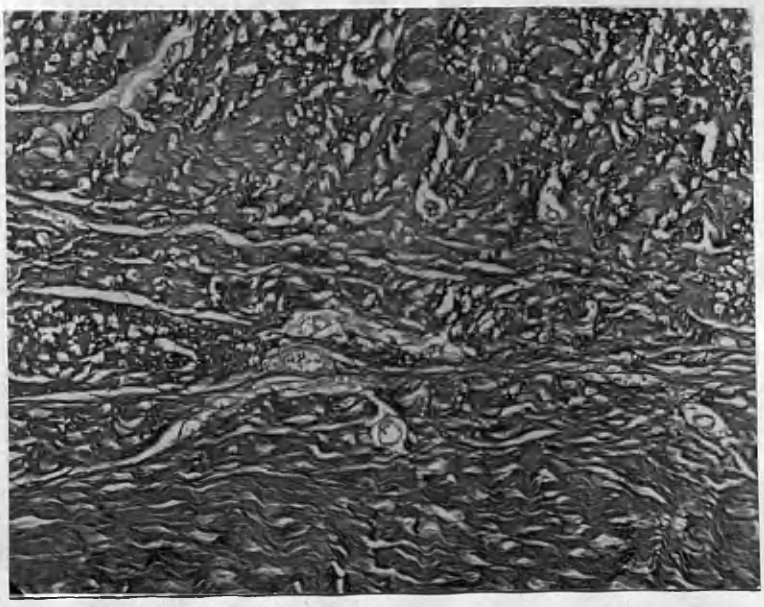


Figure 69 a. X 150.

Rabbit number nil. Human subject. Mrs. Ritchie. Graft inlaid for sixteen months. Stained by Mallory's method.

Report.

The specimen shows only fibrous tissue and blood vessels.

ADVANTAGES OF THE WHOLE SKIN METHOD.

1. In both cutis and fascial repairs, excepting McArthur's method, secondary incisions require to be made in a part outwith the inguinal incision. With the whole skin, there is always enough redundant skin to meet every requirement. The skin is removed by an eliptical incision. Where a very large piece is required, as for example with a large umbilical or ventral hernia there is inevitably a large area of redundant skin. In other words the larger the hernia the more skin there is available for use. No incision elsewhere is required.

2. The entire area of the inguinal canal is protected, and the graft laid in, in such a fashion as to overlap the pubis, narrow the internal ring, extend well up over the anterior aspect of the internal oblique, and join low down on to the inguinal ligament. There is no weak spot left in the medial aspect of the posterior wall, as when Bassini's method is used, and, as the skin is a solid plaque, there is no danger of a gap existing as in the case of fascial strands darned between the conjoined tendon and Poupart's ligament. No defect remains after the graft has been correctly disposed.

3. The operation is physiologically sound as it entails the union of the connective tissue to connective tissue under tension. This results in powerful fixation. The adhesion to the underlying muscle is less firm, and that is desirable

as muscle action below the inlay graft is permitted to continue, unhampered by scar tissue.

4. It results in a saving of time. Fascial or cutis repairs involve time loss for preparation of the grafts, and suture of the thigh wounds. Here with the whole skin this time, amounting to a few moments, is saved.

5. In my own series, the method has given better results than any other.

6. Outside of the scope of inguinal hernia, the whole skin method has the attraction that it is applicable to any type of ventral, umbilical or incisional hernia, where fascia, to be effective must be used in large quantities, implying the manufacture of a large defect in the fascia lata of the thigh and correspondingly larger thigh incision, with time loss.

DISADVANTAGES OF THE WHOLE SKIN METHOD.

1. The method is technically more difficult to perform than when fascia is used, and, in my opinion unless performed correctly with respect to the salient points in technique, may not give satisfaction.

2. Criticism has been made to me by colleagues that there is a risk of post operative sepsis, and that it is not possible to sterilise the skin. Moreover, as the skin

used comes from the pubic region it is contaminated, and staphylococci or other organisms will lurk in the depths of the hair follicles. The proof of the pudding is in the eating, and the results show that there has been a very low incidence of post operative sepsis indeed, though every wound which failed to heal absolutely cleanly by first intention has been noted. There have been no cases of late delayed sepsis.

3. It has been suggested that there is risk of epidermoid or inclusion cyst formation. Again this has failed to take place. The tissues examined both in animals and in the human subject show no signs of cyst growth. There is a complete conversion to vascular and powerful connective tissue.

4. To a novice in the use of this method, difficulty may be experienced in judging the size of the graft, learning how much the average graft stretches under tension, and effecting its proper disposition into the inguinal canal and pubis. Time is thus lost at first. In my own case the average operating time for an indirect hernia was fifty minutes for the first few operations, but after having done ten or twelve the required operating time fell to half an hour or less as a rule. In the case of recurrent hernia five or ten minutes longer may be necessary.

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AN INVESTIGATION INTO THE SURGICAL PROBLEMS OF INGUINAL, FEMORAL, UMBILICAL, VENTRAL AND CERTAIN OTHER TYPES OF ABDOMINAL HERNIAE WITH A DESCRIPTION OF A NEW PRINCIPLE OF REPAIR USING WHOLE SKIN GRAFTS IN PLACE OF FASCIA.

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CHAPTER 14.

OPERATIVE TECHNIQUE IN INGUINAL HERNIAE.

One of the factors in recurrence after these operations derives from faulty operative technique, and it must be emphasised that all steps of the operations must be performed with all possible regard for asepsis, delicate handling of tissues, control of haemorrhage, and avoidance of unnecessary trauma. A Senior Army Officer once told me in all seriousness that 'When I do a hernia I make such a hell of a mess that the resulting fibrosis prevents any recurrences.' Such a remark is worthy of publication as a warning to avoid any such repetition on the part of other people. Technique should be flawless if success is to be achieved.

Certain steps are common to all operations for inguinal herniae and points to be observed are indicated.

Preservation of Nerves. The iliohypogastric, and if possible the ilioinguinal nerves should be identified and protected from harm. The catching up of either of these structures in a suture may lead to incapacitating post-operative pain.

They may be damaged by:

1. Forcible tearing of either internal or external oblique muscles, or by clearing these structures away in the

exposure of Poupart's ligament.

The external oblique must be carefully incised, the margins of the opening picked up in mosquito forceps and the aponeurosis carefully cut under direct vision, first towards the external ring, and secondly laterally towards the anterior superior spine of the ileum.

2. When the nerves have been exposed they should not be roughly retracted out of the operating field, as this may avulse branches in the area. Instead they should be carefully dissected out for as far as is necessary to secure reasonable mobility and gently retracted on a blunt hooked retractor.
3. The external oblique aponeurosis should not be opened up by scissors from the external ring in a lateral direction as this is liable to damage the nerves.
4. Care must also be taken not to include the nerve in a deep suture placed in the muscle at a point where the nerve is embedded within it. In inserting the sutures the operator must remember the anatomy of the nerve in its course through the internal oblique and the canal.

Location of the Sac. This is dealt with in description of the operation of herniotomy, but it may be stated that if there is difficulty in identifying the sac in the substance of the spermatic cord, it can usually be easily seen at the internal ring and stripped towards its fundus from the neck.

Stripping of the Sac. When the sac has been identified it must be freed from the cord. The fundus should be seized if possible in artery or mosquito forceps. This can be identified as a gleaming white arch, contrasting with the darker tissues of the cord. When the fundus has been picked up it may be stripped by gauze dissection from the related veins, vas and nerves taking care not to cause haemorrhage, or if bleeding does start to pick up the vessel with fine artery forceps and avoiding in so doing, inclusion of the vas.

If the sac is thin it may be readily torn, but if so the peritoneum can be grasped proximal to the tear and cautiously stripped up to the neck.

Where the sac is fibrous and adherent, care must be taken to separate it right up to the neck and not leave a stump still distal to the internal ring.

Opening of the Sac. The sac should be opened to permit exploration of the interior. The finger should be introduced and inserted through the mouth to identify any adherent viscus and palpate the posterior wall of the canal from its abdominal aspect.

In opening the sac any swelling within should first be reduced. If that is impossible caution must be observed lest a hollow viscus be opened as well. If omentum is present the fat is usually fibrotic, but, if cut

or torn, may bleed. If reduced in this condition intra-peritoneal haemorrhage is probable.

Dealing with Sac Contents. If omentum is present and adherent it must be separated completely. This may be difficult and at times necessitate excision of part of the fatty mass. Care must be taken to tie off each omental adhesion between ligatures and it is wise to transfix the structure before ligating. There is a risk of the ligature slipping if this is not done, and, as omental adhesions are often powerful and vascular such a complication may be serious.

The ligation and excision of the fat should be in small sections at a time, a portion of omentum no larger than one half inch in diameter being taken in each ligature. The ligatures should be one inch apart and the severed stump at least one half inch distal to the ligature.

If bowel is present it must be returned to the abdominal cavity free from subserous haematomata or other trauma, and no traction should be made upon its mesentery owing to risk of shock and later paralytic ileus.

Excision of the Sac.

The sac having been identified and freed up to its neck, the contents disposed of, and the posterior wall of the canal palpated, the sac must be excised. It should be transfixed twice at the neck after torsion. The needle

should traverse the neck of the sac from north to south, and east to west, thus, when the ligature is tied, the sac is more completely closed at the mouth. It should be severed approximately one half inch distal to the ligature.

If the neck is wide, this method is not practicable, and a purse string suture may need to be placed around it. In large direct diffuse sacs several purse string sutures may be needed to infold it upon itself. Each successive purse string has the effect of further buttressing the posterior wall of the canal.

The ligated stump should not be stitched to the anterior abdominal wall. The anchoring suture can cause necrosis of muscle fibres and prejudice the integrity of the affected area.

Dangers to be avoided during Ligation. There may be accidental puncture of the bladder or other large blood vessel, the vas, or one of the nerves. Each incident must be appropriately dealt with, the bladder wound invaginated if necessary by one or two small purse string sutures, the haemorrhage controlled, the vas freed from the ligature, and the nerve carefully separated from its adhesion by loosening the ligature.

Repair of the incision in the Spermatic Cord. In indirect cases the coverings of the cord are incised to expose and remove the sac. When this has been done there remains an

incision in the coverings which requires repair. If the operation has not been carefully performed the coverings of the cord may be unrecognisable and no clean cut defect identifiable for suture. When the sac has been cleanly exposed and stripped the finger may be introduced into its bed and made to travel along the cord either up to the internal ring, internal to all the coverings, or down towards the epididymis. It is this rent which must be closed. It is readily done by seizing either extremity in Allis forceps and inserting a running stitch of four of cat gut.

Fascia Transversalis. In most adult cases the fascia transversalis is reinforced no matter whether simple herniotomy, fascial repair or whole skin graft inlay is going to be performed.

The fascia transversalis is identified deep to the conjoined tendon, and overlies the interval between that tendon and Poupart's ligament with which it joins. The fascia is picked up close to the conjoined tendon at the internal ring, the suture also embracing the muscular pillars of the ring, and reintroduced through the fascia immediately proximal to Poupart's ligament and the suture tied. The suture is continued in the same fashion as a running mattress right to the pubis. When completed the fascia has been infolded upon itself and a buttress effect produced.

Depending upon the nature of the operation in progress are the other steps shortly to be considered.

From the facts considered in the previous chapters it is suggested that there need be only three operations for the cure of inguinal hernia. These are the operations of simple herniotomy, with or without reinforcing the fascia transversalis, the inlay of fascial sutures, or thirdly, the use of whole skin grafts.

In regard to fascia several methods are available; the fascia may be taken from the external oblique aponeurosis, the rectus sheath, or the thigh, and finally, in lieu of fascial strips, a plaque of fascia may be used as described by Kirschner. In practice the only really satisfactory method for general use is that of fascial strips removed from the thigh. Other methods, from the rectus or external oblique do not supply sufficient length of material for the average case, though it cannot be denied that certain ones may be suitable. On the whole it is better to have too much fascia available than too little, and Gallie's method is more likely to ensure this than any of the others. The operation of herniotomy is the first step in either fascial or whole skin graft repairs and is thus not considered separately. A short description of the method followed by the author for fascia is given and a detailed account of the whole skin operation follows.

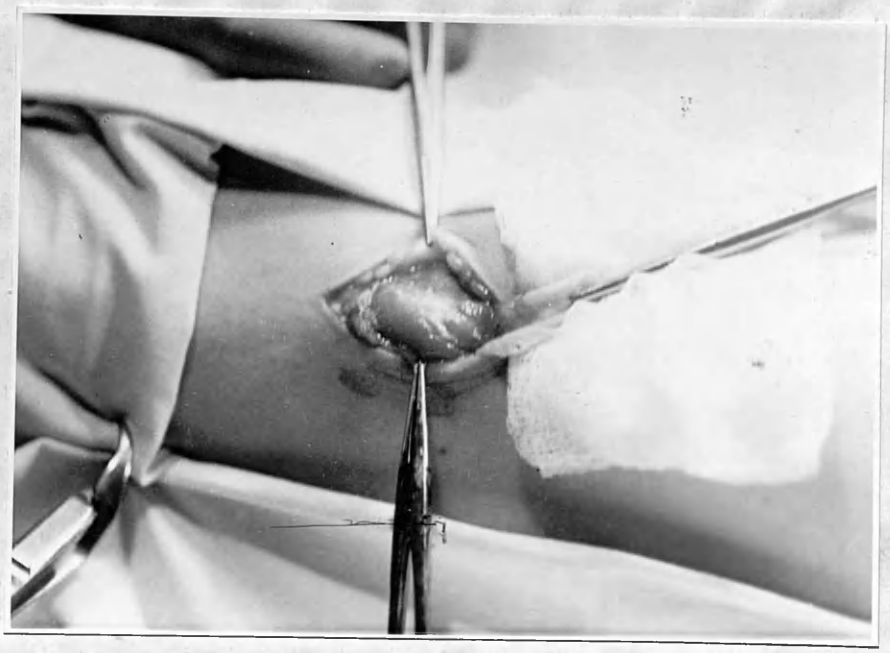

Figure 70.

Incision for exposure of fascia lata above the knee.

STAGE I. HERNIOTOMY AND STRIPPING OF FASCIA.

Pre-operative treatment. The abdominal skin is shaved from the symphysis pubis to the epigastrium, and prepared for twenty-four hours with spirit or iodine.

The thigh is shaved, and the skin of the outer aspect washed with ether soap for ten minutes. Iodine or spirit is then applied and the area enclosed in a sterile bandage.

Anaesthetic. This is discussed in the next chapter, but it is the custom in Woodend and Oldmill Emergency Hospitals to use Nitrous Oxide, Oxygen and Ether in a Boyle's apparatus, with premedication of three quarters of a c.c. of Omnopon and Scopolamine administered by injection one hour before operation.

TECHNIQUE.

The skin of the thigh is prepared by spirit swabs, and the foot internally rotated. This renders the fascia lata taut. A small incision, one to one and a half inches long, is made in the line of the fascia lata commencing just above the lateral condyle of the femur, and deepened through fat to expose the glistening fascia. (Fig. 70).

Two small parallel incisions are made in the fascia lata one third of an inch apart, and their distal extremities joined by a transverse cut. The flap of fascia

turned over from the underlying muscle is passed through the end of a Mayo or Gillies Fasciotome, and seized by a strong pair of Spencer Wells forceps. The fasciotome is then made to travel up the fascia, forceps holding it taut the while, and when it has cut a strip at least eight inches long, the proximal end is freed by a tenotome through a small incision in the upper aspect of the thigh and over the point of the fasciotome, which is readily palpated through the skin. The strip of fascia is then pulled down the leg through the inferior incision and both wounds are closed, the upper by one silk gut suture or a collodion patch, and the lower by two or three (Figure 71).

The fascia is placed in warm normal saline for use at a later stage in the operation.

Skin incision. This is centred over the external ring, runs obliquely up and parallel to the inguinal ligament for three or four inches, and medial to the external ring for at least one. It is deepened through the superficial and deep fascia to expose the glistening aponeurosis of the external oblique muscle. (Fig. 72).

Some people have advised a transverse supra pubic incision for bilateral cases. In my view that is not to be commended as it entails a good deal of retraction to gain adequate exposure.

Muscle Incision. The external oblique is carefully cleared

Figure 71.

Removal of strip of fascia from thigh by fasciotome.

Figure 72.

Skin Incision completed and aponeurosis of external oblique exposed.

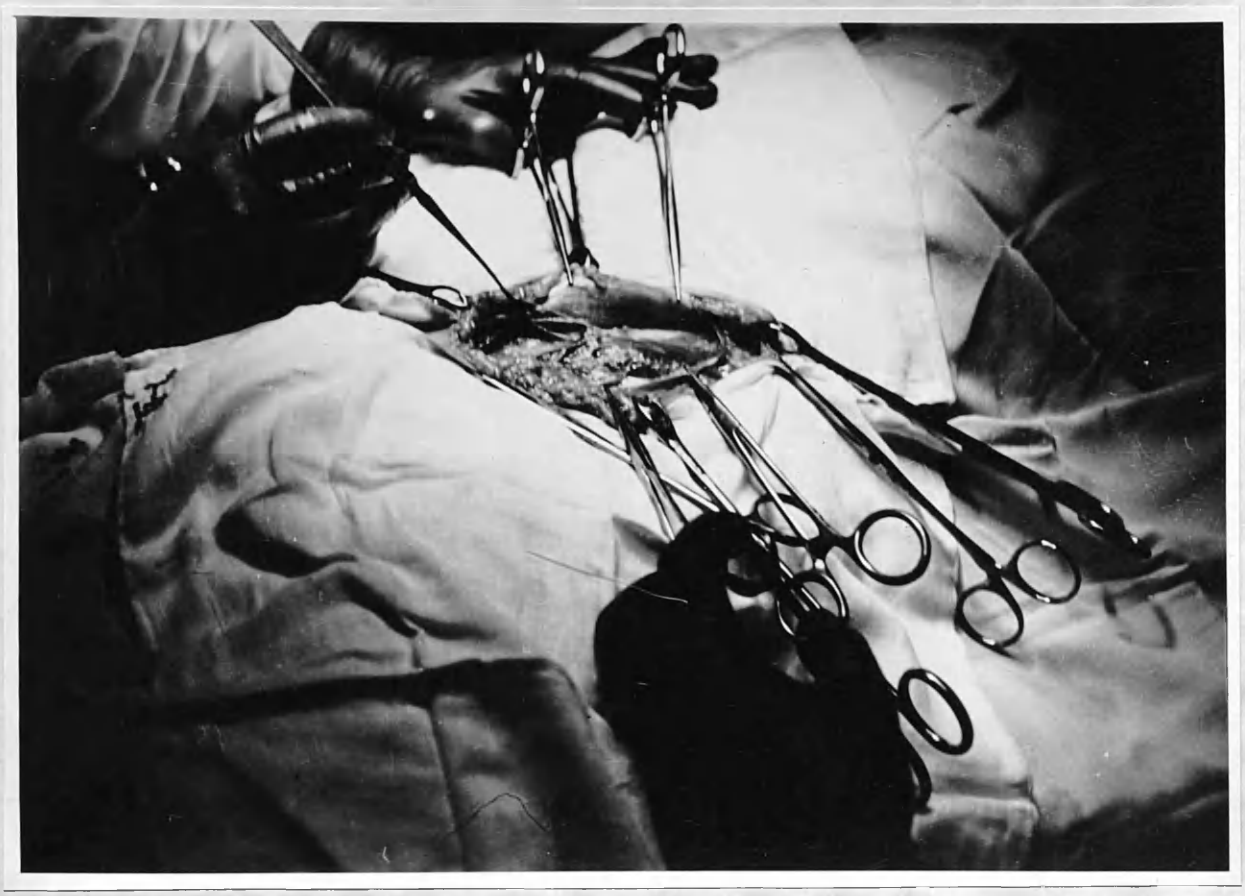

Figure 73.

The cut edges of the external oblique aponeurosis are retracted by mosquito forceps and the iliohypogastric nerve is being supported on a blunt hook.

of fat, and bleeding points tied off. A small incision is then made in the muscle, in the line of its fibres and one inch above the external ring.

The margins of this cut are seized by mosquito forceps and the aponeurosis lifted up from the underlying tissues. A finger is inserted through this small opening which presents, and swept round between the two oblique muscles. If the iliohypogastric nerve is identified it is protected from trauma. The incision in the muscle is then prolonged in the line of its fibres medially and laterally. The external ring is incised and its pillars grasped by fine mosquito forceps which act as retractors. The external spermatic fascia prolonged over the cord from the margins of the external ring is freed by gauze dissection and the cut aponeurosis retracted to expose the canal.

Iliohypogastric nerve. This nerve is usually seen adhering to the under surface of the external oblique, or running along the inferior margin of the internal. It is identified and its position noted. Fig. 73. Care is taken that it is not included in a suture.

The thinnest and weakest portion of the external oblique is over the inguinal canal! If the fibres are split above or below the middle of the canal, one flap will have this weak strip close to its margin. If the flaps

are out over the canal - the edges - viz. the weakest part of the aponeurosis, will later be best supported, making for stronger mechanical closure.

As further protection to the iliohypogastric nerve this point is important, and the muscle should be split in the weakest thinnest part over the canal, and from without inwards.

Spermatic Cord. The cord is lifted up from its bed in the canal, to expose the posterior wall, underlying conjoined tendon, and fascia transversalis. It is carefully dissected free to expose the pubis medially and internal ring laterally, with the deep epigastric vessels running up its medial side.

The fingers of the left hand are then placed below the cord and its contents spread out over them. A small incision is made through the coverings of the cord over the glistening sac, and the vas deferens palpated.

The coverings are then swept upwards and medially, and downwards and laterally respectively from the margins of the incision. The plexus of veins is retracted with the vas by gauze dissection until the fundus of the sac has been exposed. It is then grasped in mosquito forceps, and the sac carefully dissected up to as high a level as possible. If the level is not sufficiently high the deep epigastric vessels will not be exposed on its superomedial

2.

aspect.

The sac is then opened and a finger inserted to explore first, the interior for presence of a viscus or adhesions, and secondly into the abdominal canal to palpate the posterior wall of the canal from within and to seek for any weakness in it. It is important that this be gently performed as trauma to gut may predispose to the development of intra abdominal adhesions at a later date. The sac is then twisted and retracted downwards as far as possible. The base is then transfixed by a ligature and tied off. It is a wise precaution to doubly transfix the sac, the first passing through it at right angles to the second. There is thus a greater degree of obliteration of the mouth and less chance of the ligature slipping. The ligated sac is removed distal to the transfixing ligature, and the stump permitted to retract up into the abdomen.[3.] The method described is likely to result in a dimpling 'upwards' of the stump when viewed from within the abdomen and obviates any tendency to 'dimple downwards' towards the internal ring, a feature which would favour recurrence.

The sac may be adherent to the vas near the internal ring. This adhesion must be separated or else the sac will be removed at too low a level for future safety. The stump should not be sutured to the anterior abdominal wall,

as this may cause pressure necrosis of the muscle fibres held in the suture, weaken the muscle at the point of suture, and in any case prevent high retraction of the sac. [4, 5.]

The small incision in the spermatic cord is then closed by a running stitch of 'four o' cat gut. (Figure 74).

If the fascia transversalis presents a rent, or is flabby, a buttressing stitch is applied from the pillars of the internal ring throughout the length of the canal. This narrows the ring, and also helps to reinforce the posterior wall. Care must be taken not to confuse this step with a union between conjoined tendon and the inguinal ligament.

(Where a simple herniotomy only is being performed, the cord is now returned to the canal and the aponeurosis of the external oblique sutured. The fascial layers of Scarpa and Camper are also closed by a fine running cat gut suture and a few silk gut stitches approximate the skin edges).

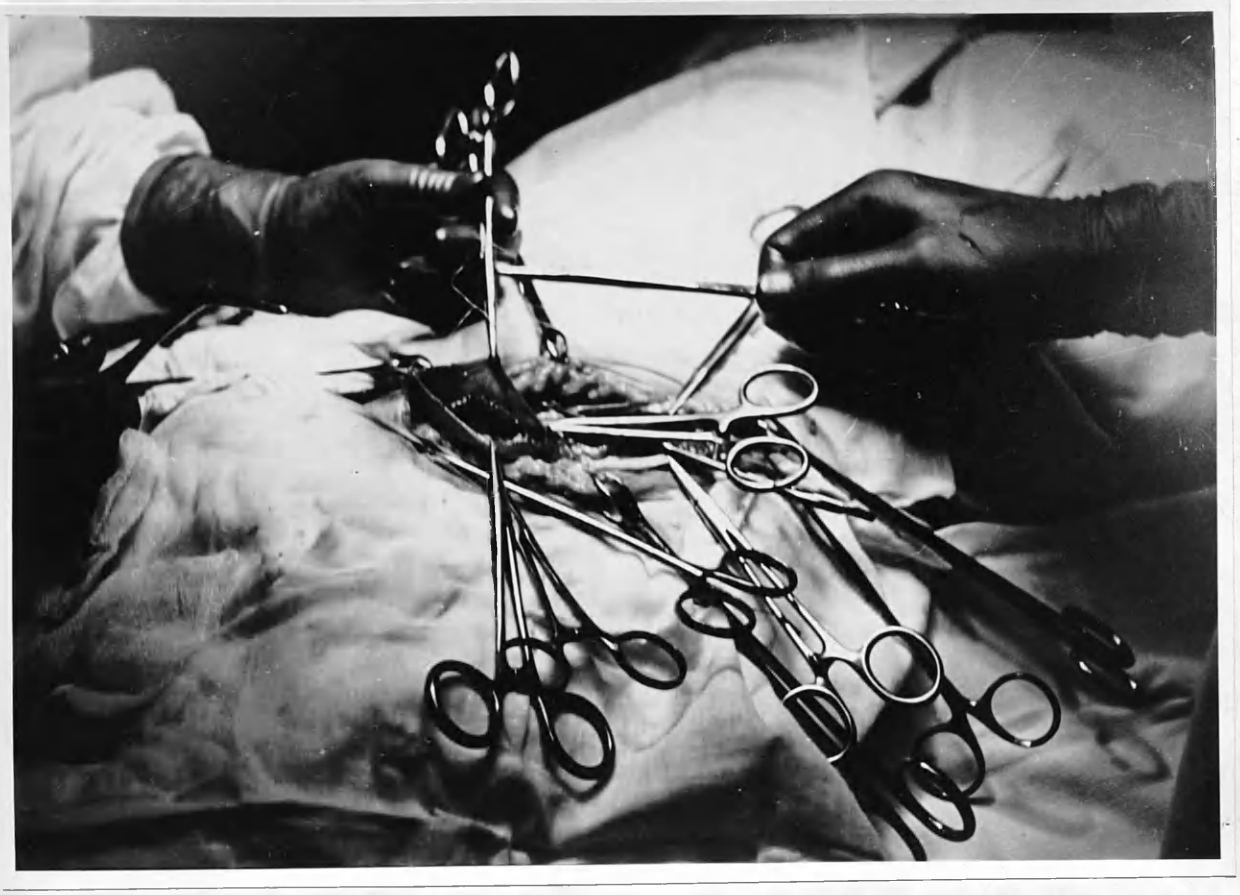

Figure 74.

Closure of the incision in the spermatic cord.

STAGE II.

PLASTIC REPAIR WITH FASCIAL SUTURES.

The fascia is threaded on to a medium sized Gallie needle and the threaded end fixed to the main strand by a linen suture.

The needle then passes through the pubic fascia and the distal end of the suture is fixed to the underlying tissue by a linen stitch. The fascia is then drawn taut and the needle made to take a bite of the medial part of the conjoined tendon near its insertion. The fascia is pulled through and the needle made to bite the shelving margin of the inguinal ligament, taking care not to pass too deeply. (Figure 75). The fascia is drawn taut once again and the proximal portion held in cat gut holding forceps whilst further stitches are inserted in continuous fashion up the entire length of the posterior wall of the canal between conjoined tendon and Poupart's ligament. The fascia is laid under a considerable degree of tension and firm bites of the muscle are taken. The final stitches are placed so as to approximate the pillars of the internal ring and narrow it, yet without risk of compressing the veins of the cord. A linen stitch anchors the final fascial stitch into position. When the fascia has been efficiently sutured between the conjoined tendon and the

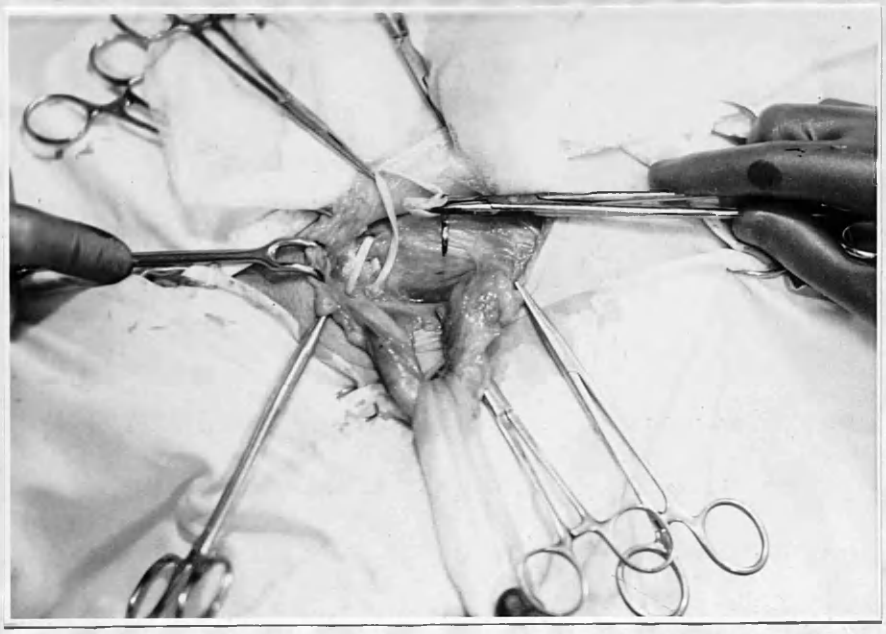

Figure 75.

The Fascial strip is threaded on the Gallie needle and being used to join the conjoined tendon to the shelfing edge of Poupart's Ligament commencing on the medial side. The margins of the external oblique aponeurosis are retracted on mosquito forceps and the spermatic cord held aside by a gauze strip.

inguinal ligament the canal is well protected, but care must be taken to see that no deficiencies exist between the sutures, that the fascia is securely anchored at each end, and that it does not tear out of its attachments to the inguinal ligament.

On many occasions the conjoined tendon is so atrophied or defective in its lower medial attachment, that the fascia has to be inlaid between the rectus sheath and ligament medially, and thence, from rectus on to internal oblique. It is also recommended that the fascia should be prolonged lateral to the internal ring for at least one half inch.

More than one fascial strip may be needed to complete the repair, and many modifications have been suggested as to the precise method of using the fascia. Gould[1.] has outlined what, in my opinion, seems to be an excellent repair. He calls it "stitching the darned patch", a title quite suitable to his technique. It is virtually a combination of Kirschner's patch of fascia lata and a Gallie repair. The disadvantage is that it requires a lot of fascia and a large thigh incision.

A film of sulphonilamide powder may be insufflated on to the surface of the canal. This step is not an admission of lack of confidence in technique, but a recognition of the fact that fascial repairs carry with

them a higher incidence of wound sepsis in many hands than do simple herniotomy or the Bassini operation. Certain authorities doubt whether sulphonamide powder applied locally does prevent or reduce sepsis, but, on the other hand many say that it does. There appears to be no argument against its use and so long as the position remains sub judice it seems to me not unwise to use it for certain conditions, fascial and skin repairs being amongst them. The edges of the external oblique are then approximated by a running suture.

The fascia of Camper and Scarpa are also closed by a fine running stitch and several interrupted silk gut sutures close the skin edges.

THE ESSENTIAL POINTS IN THE OPERATION.

1. There should be too much fascia available for use, rather than too little.

2. The needle used should not be too large or the risk of damaging the inguinal ligament is increased.

3. The fascia must be disposed so as to afford protection to the weak medial aspect of the canal lateral to the pubic tubercle. In order to ensure this the first bite of tissue taken must include the fascia over the front of the pubis.

4. To minimise dead space below the fascia, and also to give added protection to the posterior wall the fascia transversalis should be buttressed by a running stitch so as to "tuck it in" and achieve a buttress effect. This stitch should also narrow the pillars of the internal ring. It should also be remembered that this stitch applies only to fascia transversalis, and does not include inguinal ligament or conjoined tendon.

5. Care must be taken not to include the iliohypogastric nerve in any stitch. This predisposes to post operative neuralgic pain in the wound area.

6. The linen stitch used to anchor the ends of the fascia must be cut short. If the ends are too long it is apt to be extruded through a small sinus perhaps several months after operation.

OPERATIVE TECHNIQUE IN THE FEMALE.

The operation is similar to that in the male up to the point at which the canal has been opened and the round ligament exposed.

This with the attached vessels and hernail sac is picked up near its insertion and freed from the canal and major labium by blunt dissection. The round ligament is then clamped, ligatured and cut near its insertion, after which it, with the sac is dissected up to the internal ring. The sac is then opened and its interior explored. Any viscus present is found and returned to the abdomen, after which the neck of the sac together with the round ligament and vessels are transfixed as usual, ligated, and removed.

It only remains to obliterate the canal where such an indication exists, by plastic repair with fascia.

There is no need to anchor the anterior end of the round ligament to any fascial layer of the area "in order to maintain support to the uterus". Support to the uterus is not supplied to any important degree by the round ligaments.

TECHNIQUE OF WHOLE SKIN GRAFT OPERATION.

PREOPERATIVE SKIN PREPARATION.

The skin of the entire lower abdomen and upper part of the thigh is shaved three days before operation, and gently scrubbed with ether soap for ten minutes. It is then swabbed with methylated ether and a spirit compress applied by a sterile bandage in a double hip spica. This tends to ensure that the dressing does not slip. On the following day it is again washed with ether soap for ten minutes and thereafter with ether before applying once more the spirit compress and sterile hip spica. On the day before operation the same procedure is repeated, and the bandage not disturbed until arrival upon the operating table on the morning of operation. The premedication and anaesthetic are as for fascial repairs. A swab may be taken from the skin over the area to be used as a graft and immediately innoculated on to a Petri plate. This need not be done, but it has been in many of my own cases. The results have been satisfactory. Seventy-five per cent. of the swabs examined failed to show the presence of any organisms on culture. Of the others, twelve and a half per cent showed scanty colonies of staphylococci albus and the other twelve and a half per cent. non-haemolytic streptococci. None of the wounds which showed organisms

to have been on the skin surface developed any post operative sepsis, the few which did show a mild infection having been apparently sterile when the skin was implanted.

OPERATIVE TECHNIQUE.

Skin Incision.

This must be somewhat larger than that which is required for other methods. It is eliptical and commences, the superior limb, over the symphysis pubis curving upwards with the concavity down, towards the anterior superior spine for a distance of three and a half to four inches, or perhaps more depending on the size of the patient. The inferior limb commences over the external ring at the first incision, and extends up and laterally with the convexity downwards, to enclose with the superior cut, an elipse of skin which should be at least two inches and a half long and one wide at the broadest diameter. The skin incision is illustrated on Fig. 76.

The enclosed elipse is then removed and placed in warm normal saline solution.

Muscle Incision.

This is exactly as for fascial repairs, but with one slight modification. In order to expose thoroughly the anterior aspect of the pubis the external oblique is detached for a distance of approximately one half inch,

from its insertion. This step exposes well the area to which the graft will be attached medially and if it is not performed, renders the suturing of the graft to the front of the pubis difficult, and less satisfactory.

The Spermatic Cord and Sac.

The cord and sac are dealt with exactly as described in the case of simple herniotomy. When the sac has been removed and the fascia transversalis buttressed, the incision through the coverings of the cord closed and all bleeding points tied off, attention is turned to the graft.

Preparation of the Graft.

The graft is removed from the saline and all loose fatty tissue dissected from its under surface by means of either slightly curved scissors or a sharp scalpel. (Fig. 77). The skin will be found to have shrunk in size but retained its shape. The pointed ends of the elipse are cut off with the scissors and in such a fashion as to leave one extremity at least one third of an inch broad, and the other at least one quarter.

The broader end is then incised in its long axis for one half to three quarters of an inch, Fig. 78, and each tail of skin thus formed held by an Allis Forcep.

The whole is then laid into the inguinal canal, and the inferior forcep placed below the retracted cord. The forceps are then pulled upwards and laterally so that the

Figure 76.

The elliptical skin incision has almost been completed and the ellipse of skin which has to be used for a graft has been outlined.

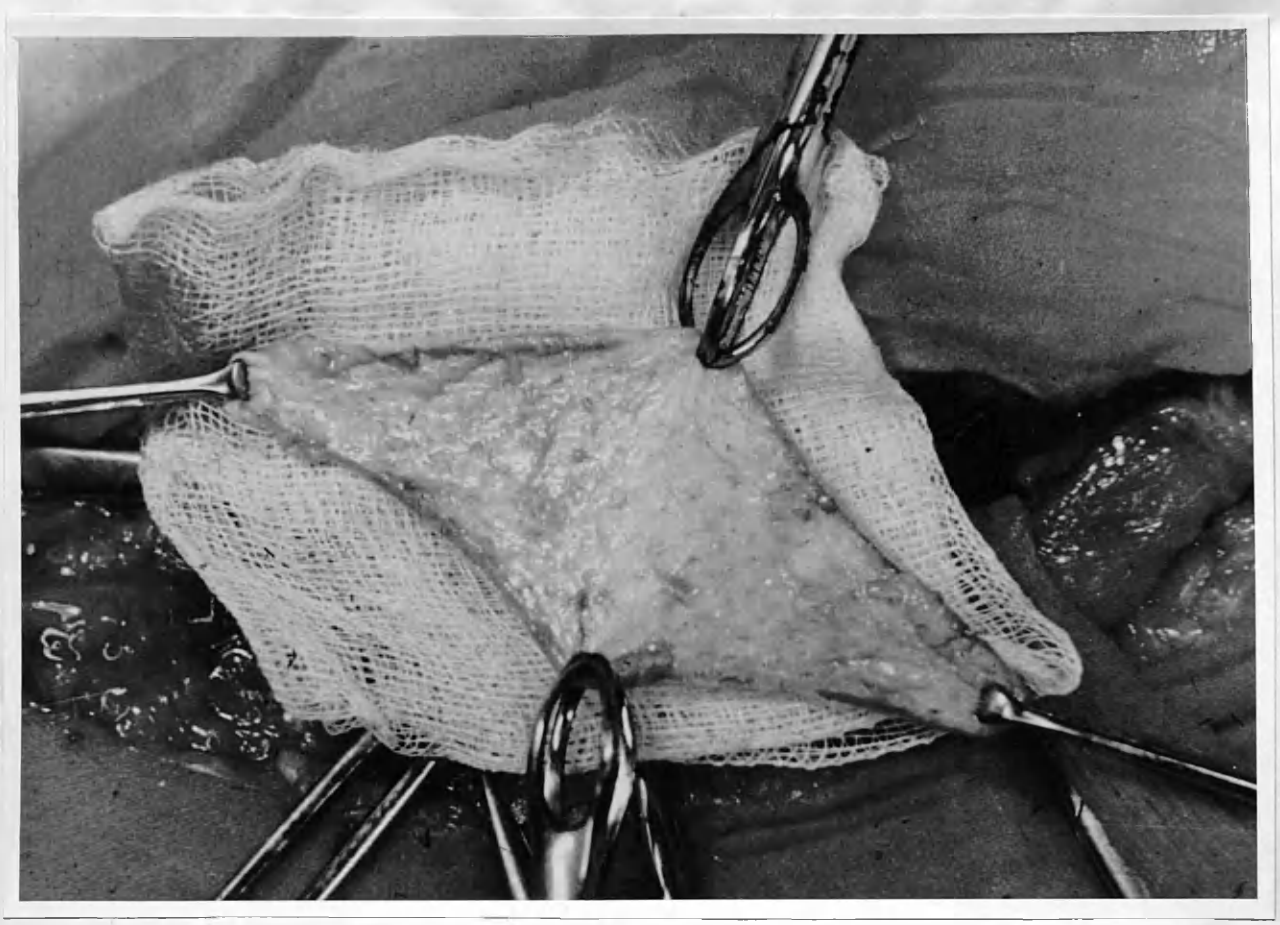

Figure 77.

The graft is exposed deep surface upwards on a swab, and the prepared surface can be seen. All fat has been removed from the dermal aspect of the graft.

apex of the V thus formed grips the inferomedial surface of the internal ring. Fig. 79.

Method of Repair.

The medial margin of the graft is seen to overlie the symphysis pubis, or is arranged so to do and is then anchored by three sutures, one to the lower anterior aspect of the rectus sheath, the second to the fascia well over the symphysis pubis, and the third to the extreme medial edge of the inguinal ligament. Care must be taken to see that these sutures stretch the medial portion of the graft tightly, and that it overlies the pubis giving satisfactory reinforcement to the potentially weak area immediately lateral to the pubis.

The superior Allis Forcep with its attached superior tail of skin is drawn gently but firmly upwards and laterally to stretch the superior edge of the graft tightly. The end of the skin pedicle or tail is then sutured to the medial aponeurotic expansion of the internal oblique. The lower pedicle is also drawn outwards and its extremity sutured to the shelving inner margin of Poupart's ligament at least one half inch above the level of the internal ring. Fig. 80.

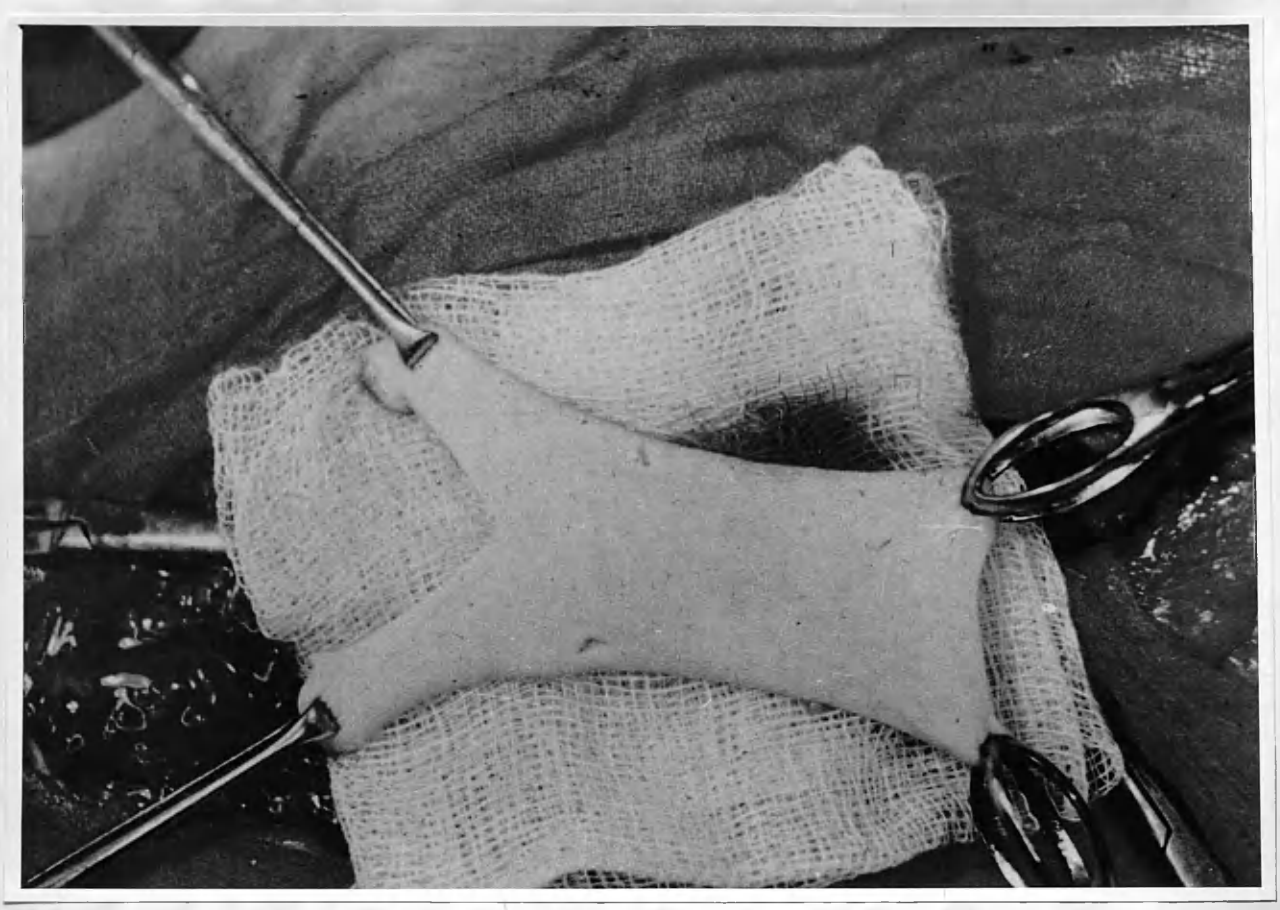

Figure 78.

The graft has been shaped and is lying epidermal aspect upwards. Observe the two tails of skin which have been formed.

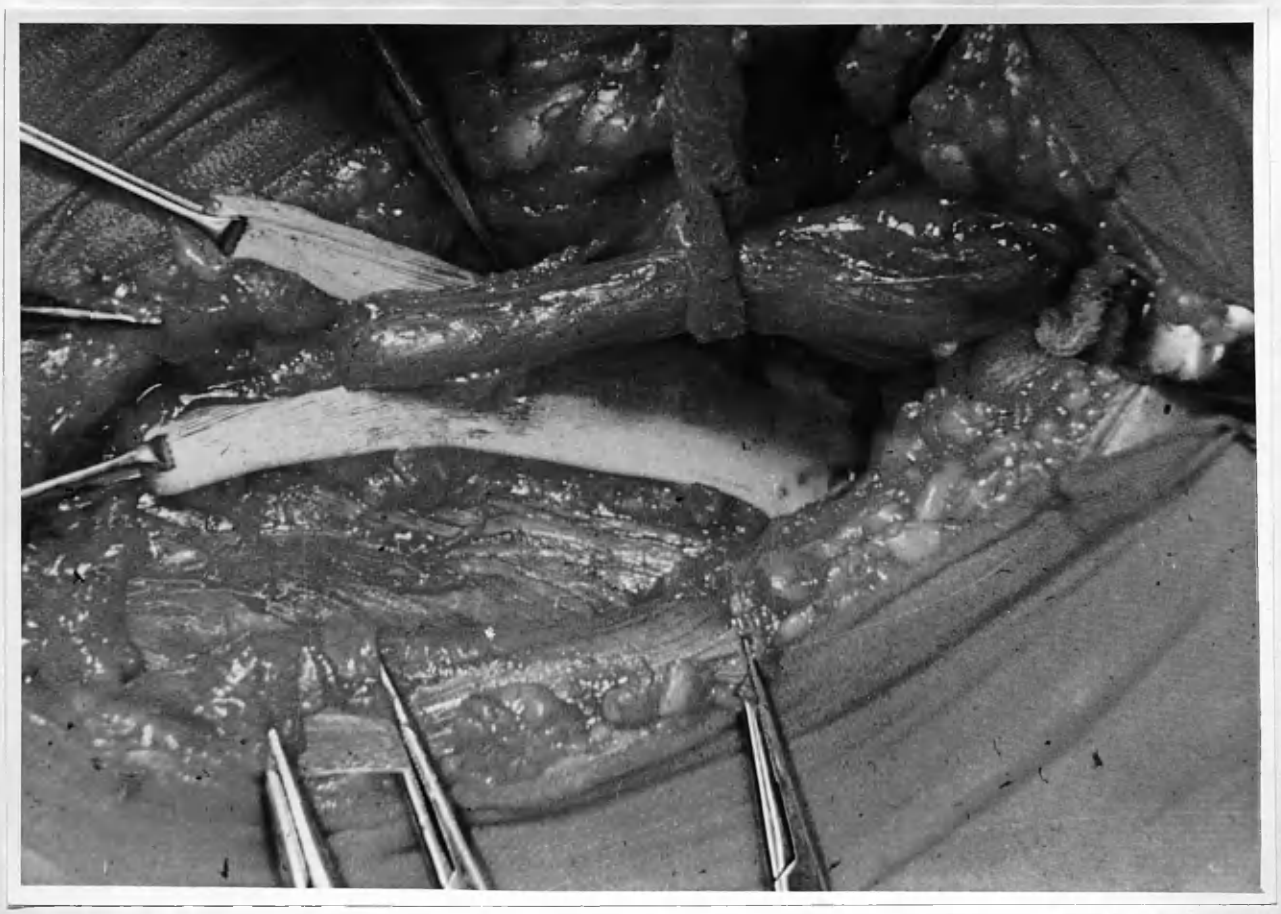

Figure 79.

The tails of the graft are controlled by Allis tissue forceps, and the graft has been laid into the inguinal canal so that the internal ring and exit of the cord from it are embraced by the skin. The medial extremity of the graft has been sutured to the fascia overlying the pubis.

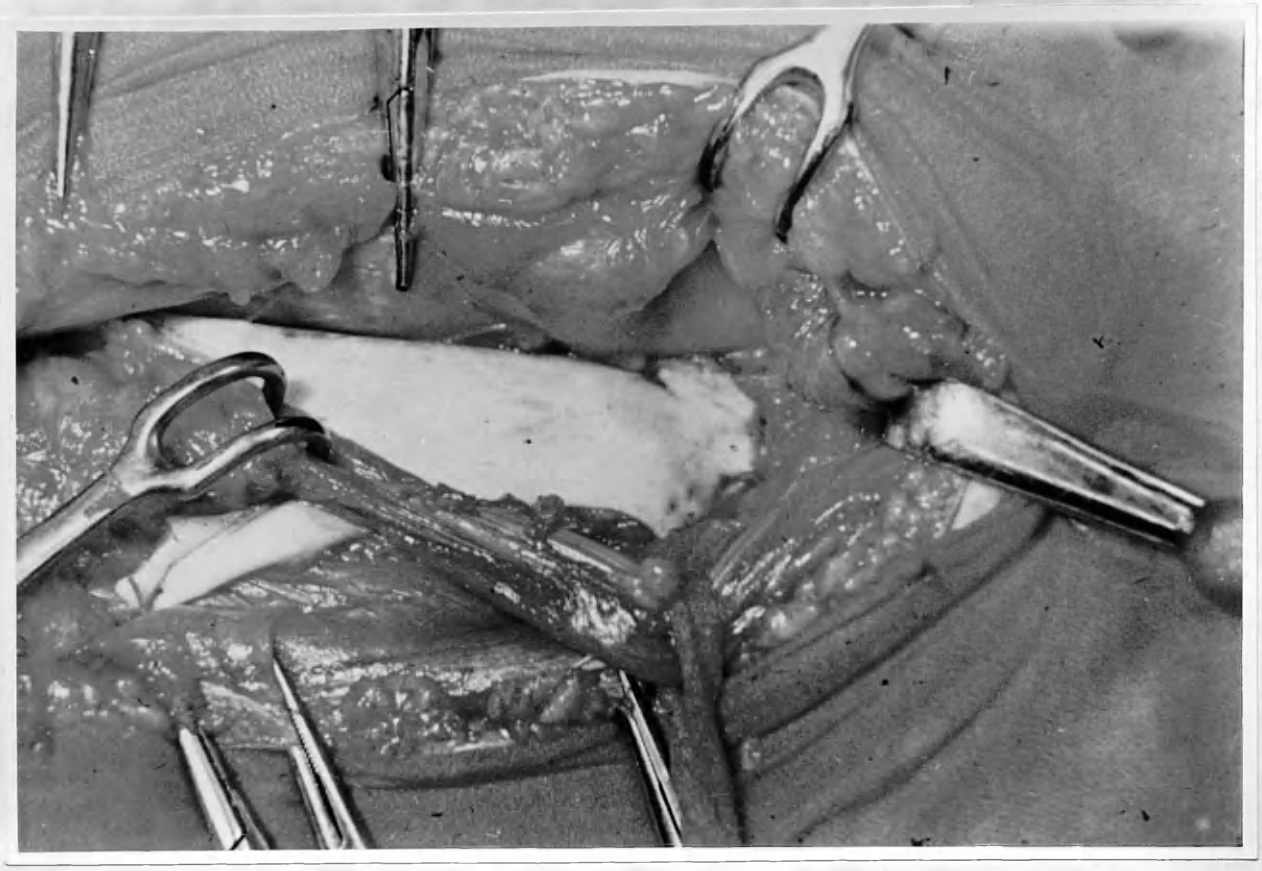

Figure 80.

The extremities of the skin pedicles have been sutured into position to the inguinal ligament below and the medial aponeurotic margin of the internal oblique above the internal ring. The graft has been stretched in its long axis.

Sutures are placed at intervals of about one quarter of an inch along the lower edge of the graft to anchor it to the inguinal ligament, and care taken that the ligament is stitched as near the floor of the canal as possible. The final row is applied to the superior edge of the graft, fixing it to the aponeurotic medial area of the internal oblique very close to the lateral edge of the rectus sheath. Fig. 81.

The outer aspect of the graft is then sutured, joining the two skin pedicles together lateral to the internal ring. This fashions a plaque of skin lateral to it as well as medial, and at the same time forms a new ring of skin over the internal muscular ring, causing the cord to arch slightly upwards in its course from the ring to the canal. Fig. 82.

In inserting the superior row of sutures, and those joining the two skin pedicles, care is taken to ensure that the graft is stitched under great tension to its attachments. When the stitches have been inserted the skin is white and blenched, tightly drawn over the floor of the canal, and in close apposition to the buttressed fascia transversalis with no dead space between.

A fine layer of sulphanilamide powder is insufflated on to the surface of the graft and the surrounding tissues, the external oblique is closed, a running suture applied

Figure 81.

The graft has now been sutured superiorly to the medial aponeurotic area of the internal oblique, and inferiorly to the shelving edge of the inguinal ligament. The inferior sutures are inserted first.

Figure 82.

The graft has been finally disposed and the skin pedicles united with each other lateral to the internal ring embracing the cord and forming a new skin ring over the former internal muscular one.

to the fascia of Scarpa and Camper, and the skin edges sutured with interrupted fine silk gut. The closed incision is generally angled like a hockey stick medially. This type of incision has found favour with several workers.[6, 7.] It is reputed to be kept more readily free from infection, to facilitate dressing, and to be more comfortable from the patient's point of view.

Finally a hip spica bandage is applied with the hip slightly flexed and in the position of physiological relaxation of the inguinal region as so often advocated by Lyle and other workers.[8, 9,10.]

POST OPERATIVE TREATMENT.

The sutures are removed on the eighth day and the patient allowed up on the twenty-first. When the patient is up and about, the operation area is subjected to stress and strain. On the other hand, prolonged immobilisation predisposes to constipation and general loss of muscle tonus. A happy medium must be struck between the two extremes. Bassini put his patient in a Plaster of Paris cast for six weeks. An Air Force Surgeon lately stated that he "was all for getting cracking a day or two after operation". Both are probably wrong but the latter more than Bassini. It is established that fascia requires three weeks to effect firm union with fascia,[11.] and there

can be no point in permitting freedom out of bed before the end of that time. There are already, in hernioplasties, sufficient dangers of recurrence without adding to them.

The question of graduated exercises in bed is important. This is only possible where skilled staff exist for the purpose, and at present, this is not to be had in all hospitals. In certain hospitals however, physical training instructors are present who attend to this important point. Exercises may be commenced on the first post operative day. At that early date, they are designed only to ensure deep breathing, and to ventilate the lungs. It is advantageous in this connection to administer carbon dioxide for five minutes every hour for the first twenty four hours after operation, thus lowering the incidence of post operative chest complications. This aspect of the post operative treatment is discussed at length by Lucas, and its importance is becoming more generally recognised. In Oldmill Hospital accurate figures are not available for the incidence of all post operative chest complications during the past three years, but it can be stated with assurance, that, since January 1944 when the carbon dioxide inhalations were made, a routine part of the post operative treatment in all cases of hernia, there has been only one post operative pneumonia and only ten cases of post operative bronchitis clearing

within seventy two hours.

By the end of one week the patient is having exercise to contract the abdominal muscles and from then on they are designed to strengthen and increase the tone of all the muscles influencing the efficiency of the inguinal canal.

The transition from bed to walking on the twenty-first or twenty-third day should not be abrupt.

Edwards has also emphasised the importance of these steps and their introduction into treatment has served further to reduce the incidence of recurrence.

The patient is not permitted to engage in any form of work for the first month after arising from bed, but during the second, is allowed to do light work. Heavy work is only permitted after three months from the date of operation.

This regime applies particularly to cases of skin and fascial repairs. Where simple removal of the sac alone has taken place the patient may be allowed up with safety on the 14th day. Otherwise the routine is as already described.

DIRECT HERNIA.

The same fundamental principles are observed in treatment and the operation is the same as for indirect, excepting that there is no occasion to incise the coverings

of the cord.

The cord is exposed and retracted to obtain a good view of the posterior wall of the canal and the type of direct sac determined, funicular or diffuse.

The sac is cleared of fat, dissected free and retracted outwards to demonstrate the neck. This is often wide and difficult to deal with by transfixion as in the indirect type. The diffuse variety can be conveniently dealt with by invaginating the sac into the peritoneal cavity with two or three purse string sutures. This causes obliteration of the sac by means of plastic reparative peritonitis.[12, 13.] When the sac is funicular it can generally be excised and transfixed. Occasionally the neck is so wide that this is not possible. Success may come by excising part and invaginating the base with purse strings as for the diffuse type.

The fascia transversalis is then buttressed over the entire posterior wall by a running suture and a plastic repair performed. This is conventionally performed with fascia, but in my view, skin may yet prove to be superior. Figure 83.

Hoguet[21.] has stated that in all direct herniae an indirect sac coexists though frequently it is extremely small. He advises that in all cases it should be carefully sought and removed.

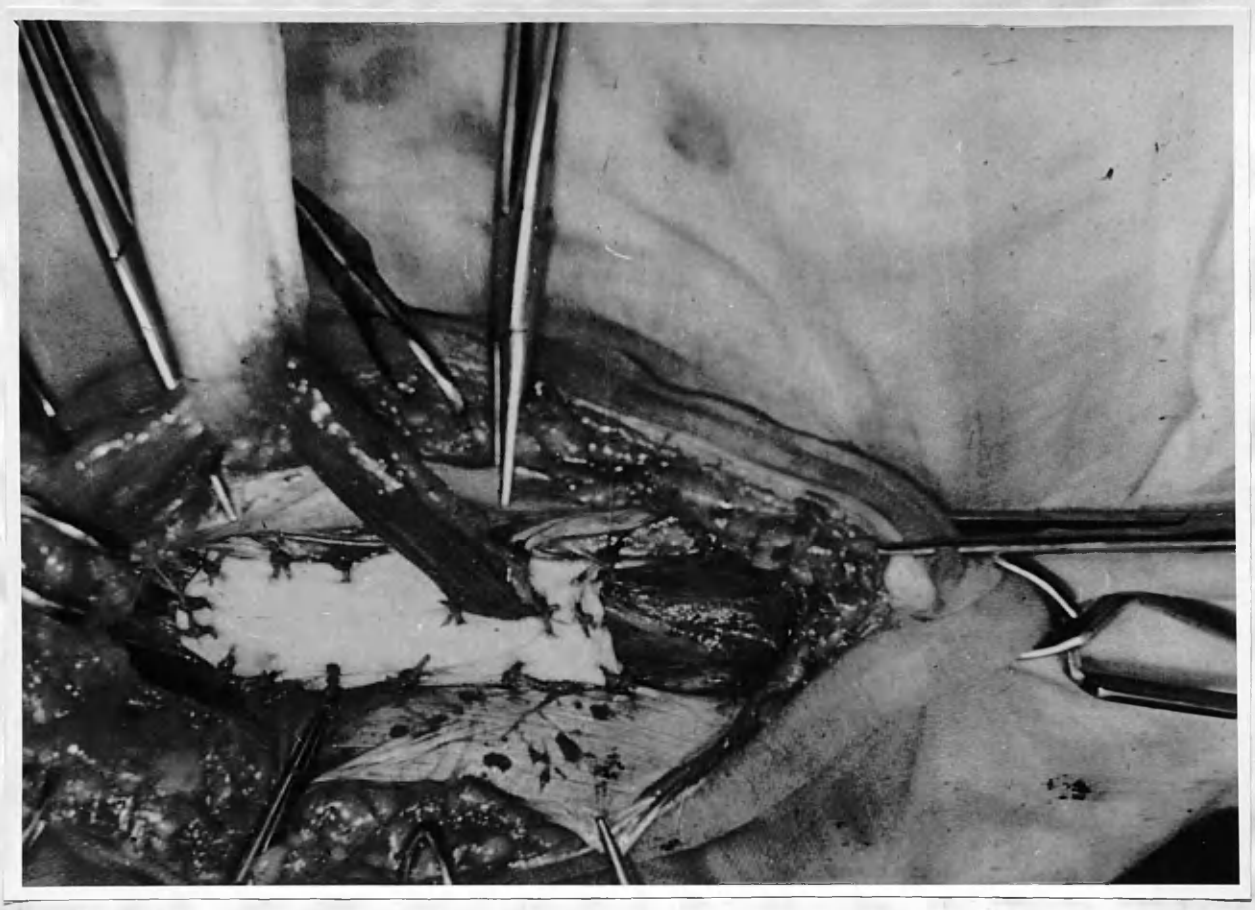

Figure 83.

A skin graft has been inlaid into the inguinal canal for repair of a diffuse type of direct hernia. The result is as already illustrated for indirect cases, Figure 82.

DIRECT - INDIRECT.

(SADDLE BAG) TYPES.

It is essential to remove both sacs. There are no special points in technique. The indirect sac is dealt with by high ligation and excision, the direct one as in the previous paragraphs.

Fascia transversalis is then buttressed as usual by a running stitch and repair with fascia or skin completes the operation.

It is important in cases of diffuse direct hernia to seek carefully for a small indirect sac as well. This may be unobtrusive, and in my experience be as small as a thumb nail. Yet if not removed - and it is easily overlooked - it may be a cause of "recurrence".

OTHER POINTS IN TECHNIQUE.

Suture Material.

The ideal ligature is perfectly reliable, strong, easily and completely sterilised whilst retaining its other properties, innocuous and non-irritating to the tissues.

The pros and cons of absorbable as opposed to non-absorbable sutures in general surgery do not properly appertain to this thesis but it is important to indicate the most suitable medium for stitching the graft and muscle

aponeurosis.

In my view, 30 day chromicised cat gut should be used for anchoring the graft and for buttressing the fascia transversalis. The sutures should be interrupted to minimise scar tissue formation.

For closing the incision in the cord three O fine cat gut is used, and for the external oblique aponeurosis number 2 cat gut as a continuous suture. If the fasciae of Scarpa and Camper are approximated three O cat gut is entirely satisfactory.

Longacre[14] and Maingot[15] prefer linen for almost all purposes. It is a common experience that linen sutures may be a cause of late sepsis, and I have personally removed at least fifteen linen sutures buried months earlier in various other Hospitals and which subsequently caused the patient to be admitted to my Wards for treatment of an abscess. The abscesses all cleared up when the offending stitch had been removed. In three cases within the past year, and all of them herniae in Soldiers, the linen was extruded spontaneously from the wound after rupture of a small superficial abscess.

In so far as the question of suture material for the use of cutis grafts is concerned, or of whole skin grafts, I am not in favour of the use of non-absorbable material

for stitching. It is a criticism of the whole skin method that there is a risk of sepsis from infection deep within the hair follicles of the skin. I admit this possibility, but suggest that in the light of my experience it is not a real danger. However, I see no reason to add to the risks of later sepsis, and thus prefer absorbable sutures for all stages of the operation.

It is also asked, does cat gut anchor the graft sufficiently long to ensure its having 'taken' before it is absorbed? There is no reason whatever to doubt that this is so. Both in animals and in the human subject the evidence is entirely overwhelming in indicating that the graft is firmly fixed by the end of three weeks, and therefore 30 day chromicised cat gut is quite adequate.

Fallis strenuously advocates use of fine silk for all purposes and says it carries no risk of sepsis.

Nilon has lately been warmly advocated. I can see few advantages in its use. Admittedly it is of uniform thickness throughout, but knots require to be tied at least three times to prevent slipping. It is sold in strands of an inconvenient length, and personally I do not care for it for any purpose.

Tension on Sutures.

It is an error in technique to tie sutures too tightly. Such a step is liable to cause necrosis of the

tissues held by the stitches, which may cut out, and in any case will lead to pressure atrophy. This may predispose to recurrence[16.] and has already been discussed in connection with uniting conjoined tendon to Poupart's ligament in the Bassini operation.

The stitches may also tear Poupart's ligament if applied under too high a degree of tension, and this is so especially when fascia is used. In the case of whole skin, it is essential that the graft be firmly anchored and rendered taut. This implies that there will be a considerable degree of pull on the fibres of the inguinal ligament. Damage to it is obviated, if the stitches are inserted close to each other, and the pressure distributed over several focal points rather than a few. It is sufficient if they are separated by approximately one quarter of an inch. In the whole skin graft method it is highly important to insert the stitches anchoring the graft to the inguinal ligament before those fixing it above. There is then minimal risk of tearing the ligament, as, when the graft is rendered taut by the superior stitches, the tension is evenly distributed over the entire length of the ligament.

TYPE OF DISSECTION USED.

It is a sound surgical principle to avoid blunt dissection, but there are several indications for contradicting this rule, and one is in clearing the operative area of areolar tissue. This can best be done by firm clean sweeps with a gauze swab.[2.] It is also permissable to employ gauze or blunt dissection in stripping the sac from its neighbouring structures within the cord. The use of a knife here may damage a small vein and cause annoying haemorrhage. At the upper end of the sac sharp dissection may be required to free any fibrous adhesion between the sac and the cord, and ensure its mobilisation.

It is important to free the lower medial insertion of the external oblique aponeurosis from the region of the pubis in order adequately to expose the area on the anterior aspect of the symphysis and lower rectus to which the graft will be attached. This is conveniently performed by means of a pair of curved scissors, and when the muscle has been detached for approximately one inch, an excellent view of the area is obtained.

In removing the fat from the under surface of the graft, it is also convenient to use slightly curved scissors in preference to a scalpel.

HAEMOSTASIS.

It may seem unnecessary to labour the importance of ensuring complete haemostasis at all phases of each operation. All vessels must be clipped and ligated systematically. It is frequently possible to clip the superficial vessels before cutting them, thus sparing what can be a free haemorrhage in the early stages.

Oozing beneath the fascial implants or skin graft may be followed by deep and late sepsis apart from tension disturbing the integrity of the anchoring sutures. Superficial haematomata may also lead to sepsis, delayed healing and predispose to recurrence. Haemorrhage or oozing can also lead to thickening and fibrosis of the cord, scrotal haematoma and later testicular atrophy. These serious complications may often be sequelae to carelessness during operation and are generally avoidable.

MANAGEMENT OF HERNIA IN OLD PEOPLE.

It has been said, and probably correctly, that elderly people with hernia suffer more pain and discomfort than younger.[17.] Further, the older the patient, the worse are results of surgery.[18.] Grace and Johnston analysed the results of operation in 1032 patients over fifty and found a primary mortality rate of 3%. The recurrence rate was

25.8% for 659 followed up cases.

In 1900 herniotomies below fifty, there were four deaths, 0.2%.[19.]

Old people frequently have worn a truss for years, give a history of chronic constipation and/or bronchitis and may not be deemed good operative risks.[20.] Huckell and others advise operation in such cases as promoting a better life risk than that of risk of strangulation. It has been suggested that in the male orchidectomy should here precede a fascial repair. According to many, age does not contra-indicate this type of treatment, and the results are stated to be satisfactory.

My own feeling is that orchidectomy should not be done except perhaps where there is otherwise little chance of closing a grossly dilated canal. The person must be aged. I have never performed an orchidectomy as a stage in repair of hernia.

On one point, treatment differs from that of a younger person. It is advisable to permit freedom from bed by the fourteenth day, thereby reducing risk of hypostatic pneumonia and cardiac failure.

In my experience herniotomy or repair in old people is a satisfactory operation and carries little risk of either death or post operative pneumonia. The patients are all most grateful for their treatment and happy in being

able to discard their trusses.

I am opposed to performing orchidectomy in those cases which require repair. The objections are based on my beliefs that:

1. The procedure is mutilating and unnecessary.

2. That even elderly people do not view with pleasure, loss of one or both testicles and often experience much mental anxiety as a sequel.

3. That there is a higher death rate when this has been done. I have no absolute figures to justify this last opinion, but in my comparatively limited experience in this operation, in various centres, more deaths have resulted than where hernioplasty alone was performed.

In dealing with hernias in aged people, however, I consider that the following points are important:

1. Administration of minimal amount of anaesthetic, and that Gas, Oxygen and Ether at the hands of a competent anaesthetist. In cases of strangulation, the use of local anaesthetic is essential.

2. Cutting down of operating time to a minimum.

3. Maintenance of a "sitting up" position after operation with breathing exercises and routine inhalations of carbon dioxide for five minutes every hour in the first forty eight hours, in order to obviate or minimise risk of post operative chest complications.

4. Permitting patient to arise from bed to a chair by the fourteenth day and to be walking by the twenty-first.

5. To pay especial regard to the efficiency of the nurses and their attention to boney prominences.
   Bed sores MUST be avoided.

With careful treatment, the results are satisfactory.

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CHAPTER 15.

ANALYSIS OF A SERIES OF INGUINAL HERNIAE, WITH DISCUSSION UPON MORBIDITY AND RECURRENCE RATES.

This section deals with an analysis of the series of 454 inguinal herniae dealt with by myself. The results are compared with those of other clinics, and the results for each type of operation contrasted against each other and against those for similar operations elsewhere.

No comparative series of figures for the skin repair is available, but my results with this method are compared with those for other methods.

In assessing morbidity and recurrence figures the conclusions reached are, with the exception of 43 cases those of myself and a colleague. In the 43 exceptions, the patients were soldiers. They were sent a questionnaire which was completed by the battalion Medical Officer. The findings are based then, in that short series of 43 cases upon the opinions of the army doctor. Each patient returned the form with a covering letter and in no instance did his opinion differ from that of the examining doctor.

For the purpose of this investigation an attempt was made to trace every patient a minimum of one year after operation. In some cases the period is well over

two years. It is of interest that of my series of 21 recurrences, all save one did recur within the first year, and most within nine months.

Number of Cases in the Series. The total number of patients was 402, but of these 52 had bilateral herniae, making a total of 454 operations. The repairs were generally performed at two different operating sessions in the bilateral cases.

Proportion of Direct to Indirect. Of the total series of 454 herniae, 104, that is 22.9% were direct. Twelve of the direct cases had an associated indirect sac on the same side and dealt with at the same operation. This association of direct and indirect sacs on the same side is known as the 'saddle bag' or 'pantaloon' type of hernia.

Association with Strain. Of the 454 herniae 319 were unassociated with any history of abnormal strain relating to the onset of the condition. 5.2% (24 cases) gave a definite history of severe strain, and 24.4% (111 cases) a history of moderate strain which, in the opinion of the patient, contributed to the onset of the condition.

Association with other Herniae. Twelve direct cases had an associated indirect sac upon the same side, and it has also been mentioned that 52 cases were bilateral. Four patients had a femoral herniae upon the contralateral side to the inguinal, two had epigastric herniae causing symptoms,

and one a large umbilical hernia.

Death Rate. One patient died on the eighth day after operation. The cause of death was obscure, and not cleared up even after autopsy. She developed signs of internal haemorrhage on the fifth post operative day and died three days later. At autopsy there was found an acute yellow atrophy of the liver and an intraperitoneal haemorrhage the source of which was not located, but was considered possibly to have sprung from an aneurysm of the splenic artery.

The operation was for a plastic repair of a large direct hernia using a whole skin graft. No technical difficulties were encountered at the operation and the death proved a most unexpected and unaccountable surprise.

Strangulation. There were ten cases of strangulation, (2.2%). In four of these the small intestine was involved, and in six, only the omentum. Resection of gut was necessary in three of the four cases involving bowel. In the omentoceles the strangulated omentum was excised. There were no deaths. No attempt was made in any case to do more than deal with the strangulation and attempt to save life.

Incarceration. Nine cases were incarcerated, (1.9%). At operation the constrictor was freed and a suitable repair performed. There were no deaths.

Reducible. The remainder of the series were reducible, (95.9%).

Associated Lesions. Hydrocele was present in 3.5% of cases, varicocele in 3%, undescended testicle in 2.2% and chronic bronchitis in 8.8%. Other conditions, for example duodenal ulcer, cholecystitis, which have no bearing upon the etiology, progress, treatment or complications of inguinal herniae are not included.

Special Types of Herniae. There was one true example of a hernia en bis sac, and seven of hernia en glissade where the caecum alone was involved. They were all on the right side. In five of the direct cases the bladder was extra saccular and related to the hernia, but caused no especial difficulty at operation.

There were two cases of cruroscrotal hernia which have been discussed elsewhere. In each, the spermatic cord left the inguinal canal not at the external ring, but by way of the femoral canal to enter the scrotum. The herniae were both inguinal.

No examples of interstitial or properitoneal herniae were encountered.

Operations performed. All cases were treated by one of four operations, a Classical Bassini, simple Herniotomy with suture of the fascia transversalis and narrowing of the pillars of the internal abdominal muscular ring, a Gallie

fascial hernioplasty or by a whole skin graft inlay. The technique of these operations have already been described.

It is necessary to discuss the complications which were associated with each operation performed.

TABLE VII.

Number of operations performed.

	Indirect Hernia	Direct Hernia	Total
Bassini	67	21	88
Herniotomy	90	4	94
Fascia	80	43	123
Skin Graft	113	36	149
Total Cases	350	104	454

In this and other tables the first figure gives the percentage and the second pair of figures indicate the number of complications out of the total number of cases considered, viz. wound sepsis for the Bassini operation is 5%, that is five cases of sepsis out of 88 operations 5/88.

TABLE VIII.

Post Operative Complications.

Complications	Bassini	Herniotomy	Fascia	Skin
Wound sepsis	5.5% 5/88	3.1% 3/94	4.8% 6/123	3.3% 5/149
Haematoma wound	1.1% 1/88	5.3% 5/94	2.4% 3/123	3.3% 5/149
Haematoma Scrotum	3.3% 3/88	1.0% 1/94	2.4% 3/123	3.3% 5/149
Orchitis	0%	0%	0%	.6% 1/149
Post Operative Chest Complications	10.2% 9/88	22.3% 21/94	13% 16/123	12.0% 18/149

Comparison of these post operative complications demonstrates that herniotomy in my experience carries with it the highest incidence of chest complications. The explanation for this is obscure, but a clue may be had in the following circumstances.

Herniotomy in Relation to Chest Complications. In Woodend and Oldmill Hospitals two distinct types of patient are encountered. Oldmill is an emergency Hospital, and Woodend a civilian. The cases admitted to Woodend, are, on the average, considerably older than those in Oldmill who, in the main are soldiers or airmen on active service. These men are accustomed to an outdoor life, whereas those

in Woodend are for the most part sedentary workers.

It has been the experience in these hospitals that there is a much higher incidence of post operative chest complications amongst the Service Cases than amongst the civilian, not only in regard to herniae but in all aspects of abdominal surgery. The operation of herniotomy is rarely performed in Woodend, where the cases usually demand some form of repair. In Oldmill the larger number can be effectively treated by simple herniotomy. It is amongst these that there has been a high incidence of post operative chest complications.

Figures are not readily available for the precise incidence of such complications for other conditions in either hospital, and time has precluded me so far from going into the matter, but it may be categorically stated that post operative chest complications are, in Woodend comparatively uncommon, whereas amongst the Service patients of Oldmill they are distressingly frequent.

The two hospitals are served by the same anaesthetists and I do the major part of the surgery in both places. Woodend is a training centre for Nurses, but in Oldmill the staff is V.A.D. and C.N.R. Nevertheless the standard of nursing is good in both. In neither are the cases, either going or coming from theatre exposed to draughts more than is usual in corridors of an institution, and no

journey in the open is required, as is so often the case in hutted emergency hospitals.

The Ward ventilation and black out arrangements are similar.

The operating theatre is superior in Woodend to that of Oldmill, but I do not see that this can play any appreciable part in the incidence of the complications under discussion.

Finally the anaesthetic apparatus is the same in both theatres. The one important difference lies in the type of patient, and there may be found a clue to the predisposition on the part of these active young men to chest troubles. It is my impression that because they are in the main living an active healthy life with abundant exercise and fresh air, that they are more liable to respiratory infections when confined indoors and under the recent War time black out regulations.

These are facts, and the suggested reasons for the higher incidence of chest complications are impressions, but the difference between the two hospitals is striking to one who works constantly in them.

Those cases of herniotomy who suffered chest complications were mainly soldiers.

Wound Sepsis. The highest incidence of wound sepsis in my series is after the classical Bassini operation. One

explanation for this may lie in the fact that these operations were performed in days when I had less surgical experience than at present.

In regard to fascia and skin, the smaller incidence of local wound sepsis follows the use of fascia. The difference is approximately 1.5%, fascia having 4.8% sepsis and skin 3.3%. They generally cleared up rapidly. One of the skin cases persisted for four months, but upon re-examination one year after the wound had finally healed there was no sign of recurrence. It is only fair to add that the degree of sepsis was slight, and that after the third week only a faint stain was present on the twenty four hour dressing.

Sepsis has given no trouble of consequence in the skin cases. It has been found that the skin graft operation is sometimes associated with a curious phase during the post operative period.

During the end of the first week, and sometimes lasting well into the third, the wound may be slightly indurated and occasionally a little inflamed. In no case has this gone on to pus formation, nor has it been associated with pyrexia, pain or constitutional upset. It is most probably due to local activity around the graft during the period of phagocytosis of the epidermis and infiltration of the graft with granulation tissue. The appearances suggest

a very low grade deep sepsis, and are not constant. It has been observed in approximately 25% of my total series. By the end of three weeks from the date of operation the wound is entirely normal, the slight superficial redness has disappeared, and the induration generally gone. Occasionally there may be some very slight deep induration for a further week or ten days.

It is important to recognise this happening and also to note that in my experience it has been of no serious significance, there has been neither subjective local upset or constitutional disturbance. The end results have been satisfactory.

Haematoma of Wound. Every effusion of blood in relation to the wound has here been considered. There has been no example of a haematoma which required to be opened or which discharged more than a few drops of blood stained fluid from a superficial bleb on the scar some time during the early second week.

Herniotomy has been associated with the highest incidence of this complication. It is my opinion that this is largely due to straining by coughing during the early post-operative period. I have also observed that these young men are frequently more restless coming out of the anaesthetic than sedentary workers, and older persons.

Haematoma of Scrotum. As might be expected haematoma of the scrotum is not common after simple herniotomy, and only one case was encountered.

The skin graft operation and the Classical Bassini have the same incidence of this complication, 3.3%. I incline to the belief that this is partly due to the sutures inserted immediately lateral to the pubis in these operations, and in the case of the skin repair, to one other factor. The external oblique is detached for about one inch from its pubic attachment in order the better to expose the pubis and lower rectus sheath. This step is sometimes associated with oozing from vessels between that muscle and the rectus. This can migrate into the scrotum to cause haematoma. There was no case of a large haematoma and seldom was there more than some scrotal discolouration with slight swelling above the testis and in the line of the cord. The condition is much more frequent when the testis has to be delivered into the wound owing to complete congenital scrotal hernia. This accounts for the bulk of the cases found.

Orchitis. This complication was observed only once, and that in relation to a skin graft repair. No explanation for it is forthcoming. The condition was not acute and subsided within a week of onset.

Comparison of personal figures with those of other Clinics.

Sepsis. O'Shea[1], found an incidence of of 3.8% sepsis in uncomplicated cases taken as a whole and without regard to type of operation. In relation to fascia, Erdman had 4.8% sepsis[2], Lyle 1%[3] and Fallis also 1%. In some hands the figure is higher. My own figure for fascial operations is 4.8%. The skin graft repair has a 3.3% incidence of sepsis after 149 operations. This compares quite favourably with the best figures for sepsis in relation to fascia, and is a little better than that quoted by O'Shea.

Post Operative Chest Complications. Lucas gave carefully detailed figures for postoperative chest complications in relation to hernia operations and for different types of anaesthetic media. He classified his complications into severe, moderate and slight. Discarding the slight cases and considering only the severe and moderate and after nitrous oxide, oxygen and ether anaesthesia, he had, for 85 cases a total incidence of 30.6% chest complications. This is higher than in my own experience for any type of hernia operation, my highest figure being for herniotomy with 22.3% chest trouble. Lucas[5] is an anaesthetist. Other figures are available from surgeons.

Davis[6] has analysed 1500 cases and found an incidence of 9.2% postoperative bronchitis after the Bassini operation. On the other hand, Gibson and Felter[7] had but 1.7%. For the

Bassini operation I found 10.2% post operative bronchitis in a series of 88 cases. The figures published range from the low level of Gibson and Felter to the high levels of Lucas, and the findings in my own series contrast quite favourably with the average. In regard to the skin operation I had 12% as against 13% with fascia.

For my purposes all cases are detailed which were associated with cough lasting for more than one day, elevation of temperature above 98.8 after the first post operative day, sputum and pain in the chest. All degrees up to bronchopneumonia and massive collapse of lung were found. These are considered in the following analysis. Any patient who had a slight cough during the first day, but was normal thereafter is not counted. This is the type of case designated mild by Lucas, and thus his figures for these mild cases are discarded when compared with my own.

TABLE VIX.

Analysis of Post Operative Chest Complications.

HERNIOTOMY.	22·3%.
BASSINI.	10·2%.
FASCIA.	13·0%.
SKIN.	12·0%.

Scrotal Haematoma. Gibson and Felter[7.] had 3.1% scrotal haematomata for the Bassini operation. This is almost the same as my own findings for the Bassini and for the Skin operations, 3.3% and 3.3% respectively. For fascia and herniotomy my own experience has been more fortunate.

Erdman[2.] in relation to fascia had 9% scrotal haematomata. This is considerably higher than my own figures for fascia 2.4%, and also for skin, 3.3%.

Davis[6.] had 7% haematoma for the Bassini operation, a figure higher than those of Gibson and Felter or myself. Fallis[4.] had only .8% scrotal haematoma in his series. This is substantially better than my own experience for any type of plastic repair.

Summary. The figures of my series compare quite favourably with those considered from other sources, and the skin graft operation is not associated with any high incidence of early postoperative complications of significance. In my hands the post operative complications for fascia and skin grafts run closely together, and with no significant difference between.

It is necessary to compare the late results of the various operations which were followed up, and to endeavour to assess the evidence in relation to the efficiency or otherwise of the skin repair.

Late Results of Operations for Inguinal Hernia.

It was not possible to follow up all the cases, though a considerable effort was made to do so. In some instances the patients were abroad, in others they had migrated to another part of the country, and in a few they had died of old age or other natural cause unrelated to the hernia.

With few exceptions the results are determined by examination one year or over the date of the original operation. In some cases an opportunity arose to see the patients within a year.

A table is appended to show the interval after operation before re-examination in relation to each of the four operations under consideration.

TABLE X.

Interval after operation before re-examination.

Duration in months	6-9	9-12	12-15	15-18	18-24	24-30	30-36
Bassini	0	0	4	11	9	4	
Herniotomy	4	7	15	4	3	3	
Fascia	0	0	30	15	30	10	1
Skin	3	9	66	9			

Thus, of the 454 operations performed 237 were followed up, and of these, 212 were observed after one year.

For the purpose of assessing morbidity and recurrence rates each case was examined by two people, myself and a colleague. 43 of the cases were in soldiers where it was not possible to re-examine them personally. They were sent a questionnaire which was filled in by their Army Medical Officer. In several cases there had been a recurrence and it was possible to arrange for the man to be sent to Aberdeen for re-examination and treatment by myself.

TABLE XI.

Late Post operative Complications.

	Bassini	Herniotomy	Fascia	Skin
Pain in the Wound	14.2% 4/28	0%	5.8% 5/86	1.1% 1/87
Pain in the thigh wound	0%	0%	25% 21/87	0%
Hydrocele	0%	0%	0%	1.1% 1/87
Varicocele	0%	0%	0%	0%
Atrophy of Testis	0%	2.7% 1/36	0%	0%
Fatigue	11.5% 3/26	0%	2.3% 2/86	0%
Thickening of epididymis, or chronic orchitis	7.6% 2/26	5.5% 2/36	1.1% 1/86	1.1% 1/87

In the case of the Bassini and the group of herniotomies, the numbers traced are not large, and not nearly so large as

might have been obtained in peace time, but, suitable comparisons may legitimately be made in regard to the fascia and skin repairs.

Pain in the Wound. This is more common after fascia than with skin, 5.8% as opposed to 1.1%. I have been unable to trace observations based upon statistical evidence for this late complication in the literature, but feel that in the case of the series of skin graft cases the numbers are not high enough to be an adverse criticism of the operation.

It is not easy to assess precisely any subjective symptom such as wound pain. One can be guided only by the patients' expressions of opinion. I have included each who complained of any wound pain at all. Certain people have stated that they occasionally were aware of a 'funny feeling' in the operation area. This seems to be interpreted as meaning 'an awareness of the scar' and generally observed after exercise or when sweating. It has not been included as 'pain'. It was not commonly met.

Pain in the Thigh Wound. This complication is peculiar to fascial operations. Again it is a subjective symptom. I found no instance where pain was complained of at the time of re-examination, but a number of patients stated that they had experienced pain in the thigh wound after leaving hospital. This persisted for only a few weeks in the average case, and for two months in one patient. Usually

it was not severe, and in no case had it obliged him to refer the matter to his doctor.

Hydrocele. This complication has been indicated in the literature as occurring as often as in 13.4% of cases after the Bassini operation.[8] Gibson and Felter observed it in 4% of their Bassini cases,[7] and Patterson in 3.8% after fascial repairs.[9]

Only one case was found in my total series, and that followed a skin repair. The hydrocele was small and symptomless.

Varicocele. No cases of varicocele were found.

In my view the absence of varicoceles and the presence of only one hydrocele is important in relation to the skin repair. It has been suggested by colleagues that the skin may be stitched so tightly around the internal ring as to compress the cord and give rise to one or other of these complications. Theoretically this is so, and yet, though the skin has in each case been disposed so as to protect effectively the internal ring, there have been no signs that the procedure is fraught with danger.

Atrophy of testis. This complication also might be expected if the cord were too tightly compressed. It was found only once, and that following upon a herniotomy. The operation was complicated by a haematoma of scrotum which later lead to the atrophy. The haematoma was not so large as might

have been expected in view of the sequel, but was approximately the size of a duck egg.

Fatigue. This symptom may be complained of for long after any operation, and it is curious that it is more common in my series after Bassini repairs than by other methods. This must, I think, be due to coincidence. There is no reason why the Bassini operation should be more than usually prone to this complication.

Chronic epididymo orchitis. This term is used here to embrace thickening of the cord in the upper scrotum, epididymitis, orchitis and epididymo-orchitis. Obviously these conditions need not owe their origin to previous hernia operation.

Erdman found 15% of Bassini cases showing late thickening of the cord in the upper part of the scrotum. It is not a condition which is commonly discussed in the literature, and I could find no other quoted figures for the lesion.

In my own series it was most common after the Bassini, and secondly after the herniotomies, 7.6% and 5.5% respectively. The fascial and skin repairs were equal with 1.1% each. I am not able to suggest any reason for these facts. It is possible again that the higher incidence among the Bassini operations is due to the fact that these were mainly done some years ago when I had less experience.

Local trauma at operation may be a cause.

Summary. In the analysis of the followed up cases for late complications, the results for the skin repair compare very favourably with those for other operations, and against those for other surgeons. There is no evidence to suggest that the operation is associated with any danger of late difficulties referable to the implantation of the skin.

It is, in fact, surprising how completely free from deep thickening the operation area is. The scar is usually satisfactory. Figures for keloid changes in the scars of the skin operation as opposed to the usual incision were not taken owing to the complication not crossing my mind. That is to say I encountered no cases in relation to the skin operation which would have drawn my attention to the possibility.

I can report that the late results of these skin repairs have been satisfactory so far as morbidity is concerned.

The data peculiar to both types of inguinal hernia, and especially in regard to recurrence figures, is now considered.

INDIRECT INGUINAL HERNIA.

Sex Incidence. There were 350 indirect herniae, of which 4% (14) were females.

Situation. 212 (60.5%) were on the right side, 138 on the left.

Type of Operation. The cases were dealt with according to Table XII.

TABLE XII.

Type of Operation	Bassini	Herniotomy	Fascia	Skin
Number of Cases	67	90	80	113

It is seen that approximately three fourths of the cases required some form of repair.

Recurrence Rate. Every case which presented a bulge over the operation area was considered to be a recurrence. If there were any doubt as to the presence of a recurrence it was listed as one. A cure was claimed only where there was no doubt.

The Bassini Operation. All the Bassini Cases which were traced were re-examined more than one year after operation.

There were five recurrences in all, three after direct hernia and two after operation for indirect. Of the 67 Bassini operations performed for indirect inguinal

hernia it was possible to trace only 22, and of these there were two recurrences, 9%.

Of the two recurrences, one was examined thirteen months after operation and the other twenty four. The first recurred after five months, and the second after three.

Simple Herniotomy combined with suture of the fascia transversalis. This conservative operation was performed in 90 cases, and the late result traced in 32. There were two recurrences 6.2%. Of these, one recurred at the end of the first post operative month, and the second was uncertain as to how long after operation before the swelling reappeared.

Fascial Repair by the Gallie Method. This method was used in 80 cases and the results traced in 59. There were two recurrences, 3.3%, one after eight months, and the other after four.

Whole Skin Graft Repair. The operation was performed 113 times and the results traced in 86. There was one recurrence 1.1%. This followed six months after operation and two months after return to work. The skin repair was performed on a recurrent hernia originally repaired by fascia in a man aged 54. The hernia recurred ten months after the original operation and a skin repair was performed for the recurrence.

The graft was anchored with linen sutures. At the operation for recurrence each linen stitch was surrounded by a minute focus of infection in which there was a pool of pus. From the pus no organisms were cultured. The graft had failed to attach itself at the medial end and the recurrence was in the form of a large direct hernia. The final repair was difficult. Owing to the presence of the pus no fascia or skin could be used, and so a Bassini type of repair was performed. The patient was kept in bed for four weeks, and at present, two months after the third operation is well.

These results are considered in the following table.

TABLE XIII.

Recurrence Rates after Operations.

Type of Operation	Number performed	Number traced	% Recurrence
Classical Bassini	67	22	9%
Herniotomy	90	32	6.2%
Fascial Repair	80	59	3.3%
Whole Skin Graft	113	86	1.1%

DIRECT INGUINAL HERNIAE.

A total number of 104 operations were performed for direct inguinal hernia.

Sex Incidence. 98 were in males 94.2% the remainder in females. All were in adults.

Situation. 54 were on the right side 51.9%.

Type of Operation. The cases were dealt with according to the following table.

TABLE XIV.

Type of Operation	Bassini	Herniotomy	Fascia	Whole Skin
Number of Cases	21	4	43	36

In the cases which were dealt with by herniotomy the sac was funicular and after its removal the rent in the fascia transversalis was sutured by a continuous stitch of chromicised cat gut.

Recurrence Rate. The same rigid criteria of cure were demanded in these as for the indirect cases. Each was examined by a colleague and if there were any doubt as to cure it was listed as a recurrence.

Type of Direct Hernia. Of the total number of direct herniae, 32 were diffuse and 57 funicular. The remainder were either recurrent or associated with an indirect sac.

The Bassini Operation. Twenty one patients were treated by this method and of these only four were traced. There were three recurrences, 75%. These recurred ten, three and eight months respectively after operation. I have seen no worse recurrence rate than this reported anywhere for direct hernia. One can only comment that the number is too small to be significant.

Simple Herniotomy. This was performed for the funicular type of direct hernia in four cases all of which were traced. Recurrence had followed in three, 75%. These cases recurred four, five and four months after operation respectively.

Fascial repair by the Gallie Method. 43 operations of this type were performed and of these 27 were followed up for re-examination. There were eight recurrences. All were examined after an interval of at least one year, and they recurred after six months, three months, fourteen, six, three and six months respectively. In two cases the patients were uncertain as to how long after operation before the swelling reappeared.

The recurrence rate is 29%.

Skin Graft Repair. This technique was used in 36 cases and the late results traced in 27. There was no true recurrence, but one patient developed a femoral hernia on the same side as the skin operation. This patient had a

long and complicated history of hernia. He was operated on originally for an indirect hernia and a Bassini repair performed. A recurrence developed and I did a fascial repair. This recurred and the third operation was for a direct recurrent hernia. The skin technique was used. On examination ten months after operation he was found to have a small but very typical femoral hernia. The posterior wall of the inguinal canal was perfectly firm and sound. I do not feel inclined to regard this as a recurrence. It should be mentioned that the patient has a direct inguinal hernia on the other side and is a chronic bronchitic. He is aesthenic in type and altogether a poor type of operative subject.

These results are now considered in tabular form.

TABLE XV.

Results of operation for Direct Inguinal Hernia.

Type of Operation	Number performed	Number traced	% Recurrence
Classical Bassini	21	4	75%
Herniotomy	4	4	75%
Fascial Graft	43	27	29%
Skin Graft	36	27	0% one femoral hernia later developed

COMPARISON OF RESULTS WITH THOSE OF OTHER CLINICS.

Indirect Inguinal Herniae. Tables of recurrence rates for these cases have been listed elsewhere. It has been recorded that my figures for the Bassini operation, for herniotomy and for fascia correspond closely with those of the average worker and are somewhat better than some, though not quite so good as others.

In the case of the skin graft series the results are satisfactory. It can be claimed that there has not been a recurrence after primary operation. The only recurrence taking place after previous fascial hernioplasty.

Direct Inguinal Hernia. The numbers of cases traced are small so far as any series of operations is concerned, but in the small numbers of Bassinis and Herniotomies they are so small as to be of little value. The results are very bad. It was bad judgment to do a herniotomy with suture of fascia transversalis in the funicular direct cases. Even with fascia the results are poor and there is an obvious and dramatic improvement with whole skin.

The results with the skin technique exceed any claims I have observed in the literature for this type of condition.

Selection of Cases. It may be repeated that there has been no selection of cases and that the series reported is consecutive embracing all herniae with which I have had to

deal during the past six years.

A total of 237 operative late results were traced, with 21 recurrences, 8.8%. Leaving the skin repairs out of consideration there were 20 recurrences in a series of 150 traced cases, 13.3%.

TABLE XVI.

Analysis of Recurrent Cases.

Case No. in Appendix	Type of Hernia	Interval before recurrence	Type of original operation	Type of Recurrence	Age	Sex
476	Left Ind.	4/12	Fascia	Direct	40	M
283	Rt. Ind.	4/12	Herniotomy	Direct	18	M
282	Saddle bag	5/12	Bassini	Direct	58	M
271	Saddle bag	6/12	Skin	Direct	53	M
239	Left D.	8/12	Bassini	Direct	39	M
228	Rt. Ind.	?	Herniotomy	Indirect	40	M
209	Left D.	6/12	Fascia	Direct	27	M
219	Rt. Ind.	5/12	Herniotomy	Direct	19	M
198	Left Ind.	3/12	Bassini	Indirect	30	M
201	Rt. Ind.	4/12	Herniotomy	Direct	19	M
208	Left Ind.	3/12	Fascia	Direct	25	M
187	Right Ind.	14/12	Fascia	Direct	61	M
190	Left D.	6/12	Fascia	Direct	32	M
169	Rt. Dir.	?	Herniotomy	Indirect	23	M
154	Left Dir.	3/12	Bassini	Direct	54	M
155	Left Ind.	8/12	Fascia	Indirect	64	M
140	Rt. Ind.	3/12	Fascia	Direct	54	M
143	Rt. Ind.	?	Fascia	Direct	41	M
125	Left Ind.	6/12	Fascia	Direct	49	M
88	Rt. D.	?	Fascia	Direct	51	M
1	Rt. Ind.	10/12	Bassini	Direct	44	M

A study of this table reveals several interesting facts.

Sex. All the recurrences encountered were in males.

Duration before Recurrence. With one exception all recurred under one year of operation, and of the twenty one recurrences 13 did so on the sixth month or earlier. In four instances the patient was uncertain as to the time interval before the reappearance of the swelling. Thus, in 13 out of seventeen cases, 76.4% of recurrences developed in the first post-operative six months.

Type of Recurrence. Four cases only recurred as indirect herniae, and in one of these the original operation was for a direct.

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CHAPTER 16.

FEMORAL HERNIA.

Definition. A femoral hernia is a protrusion of an abdominal or pelvic viscus through the femoral ring into the femoral canal.

Sex Incidence. The condition is more frequent in females, and according to Berger[1.] constitutes 32.17% of all cases as against 5% of all male herniae. In either sex it is less common than the inguinal variety.

Coley[3.] out of 75,535 herniae admitted to the New York Hospital for Crippled and Ruptured Children, found a relative frequency of one femoral to seventeen inguinal. This is approximately the proportion found in the London Truss Society. In my series of 500 cases 438 were inguinal and 20 femoral, a proportion of 22 to one.

ANATOMY.

The femoral canal is located lateral to the pubis, medial to the femoral vein, anterior to the pectineus muscle and deep to Poupart's ligament. It is the most medial of three compartments formed by septae from the femoral sheath.

The Femoral Sheath. This structure is formed by the downward prolongation of the fasciae lining the abdomen behind the inguinal ligament, the transversalis fascia being

continued downwards anterior to the femoral vessels, and the iliopectineal fascia posterior, Figure 84.

The sheath is funnel shaped with the broader end directed upwards. The inferior extremity fuses with the fascial coats of the vessels approximately three and a half centimetres below Poupart's ligament. The medial wall directs obliquely downwards and laterally, whilst the lateral is vertical and shorter.

The medial wall is penetrated by the long saphenous vein and the lateral by the lumboinguinal nerve.

The sheath surrounds the femoral artery and vein but also contains an appreciable amount of loose connective tissue and fat, in which these vessels are embedded.

Two septae are described. These pass in an antero posterior direction from the anterior wall of the sheath to the posterior, to form three compartments. The most lateral of these houses the femoral artery, the middle the femoral vein, and the medial is known as the femoral canal. It contains some fat and lymphatic tissue. Figure 85.

The Femoral Canal is conical and one half inch in length. It extends from the femoral ring deep to Poupart's ligament to the point where the femoral sheath fuses with the wall of the vein. In diameter it is one half inch at the proximal end.

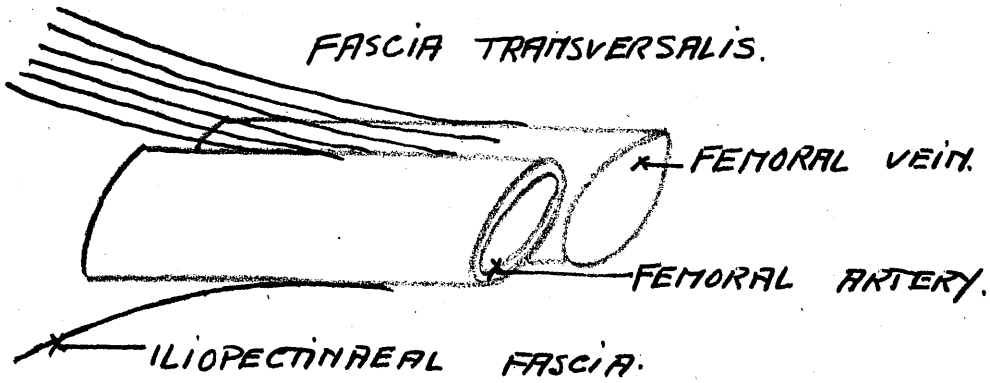

Figure 84.

Relation of the fascia transversalis and iliopectineal fascia to the femoral vessels.

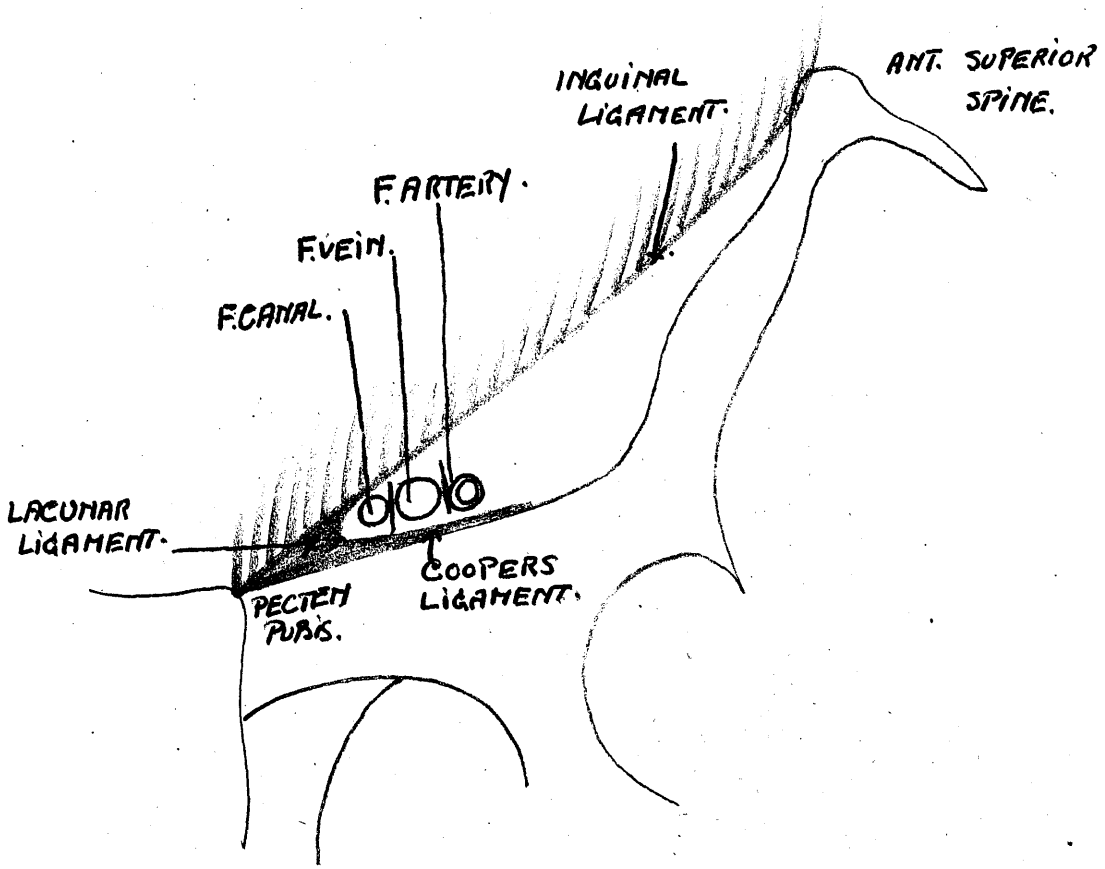

Figure 85.

Relations of the femoral canal.

The Femoral Ring. This is a rigid, or three fourths rigid ring deep to Poupart's ligament which opens from the extra peritoneal tissues of the false pelvis to the femoral canal. It bears certain important relations. Anteriorly bounded by the deep aspect of Poupart's ligament, posteriorly by the pectineus muscle overlaid by the fascia pectineus, medially by a fascial septum lateral to which is the femoral vein, and medially by the crescentic edge of Gimbernat's ligament. Superficial to the inguinal ligament it is overlaid by the spermatic cord in the male and round ligament in the female, whilst the deep epigastric vessels relate to the upper and lateral angle of the ring.

On its peritoneal aspect the ring is closed by a fascial condensation of extraperitoneal connective tissue termed the septum crurale. This is overlaid by parietal peritoneum, and pierced by numerous small lymphatic vessels uniting the deep inguinal to the external iliac lymphatic glands.

Immediately over lying the femoral ring the peritoneum presents a shallow dimple known as the femoral fossa. This is a normal condition, but demonstrates that even in the normal subject there is a "dimpling downwards" of the related peritoneum towards the canal and apparently every reason for the development of a hernia. There is no valvular mechanism to close the ring or canal, and the ring

is roofed only by a quite thin condensation of fibrous tissue. The ring is comparatively rigid and one must reflect as to why femoral hernia is so infrequent. By comparison with the inguinal canal it is to all appearances more vulnerable. The canal and ring relate to certain important structures.

Femoral Vein. The immediate proximity of the femoral vein renders any attempt at closing the ring mechanically difficult. Moreover, in any operation for complication such as strangulation or obstruction, its presence must be remembered and any cutting edge directed away from it.

The femoral vein receives the saphenous vein on its medial side. Where this structure enters the vein also bears an important relationship to femoral hernia as the saphenous vein will be in close proximity to the sac.

Saphenous Vein. This is the longest vein in the body. It conducts a large proportion of the returning venous blood of the lower limb back to the external iliac via the femoral with which it unites in the upper thigh in relation to the femoral canal.

It lies superficial to the deep fascia of the lower limb up to the last short part of its course, where, about one inch from its junction with the femoral, it penetrates the deep fascia at the Fossa Ovalis (Saphenous opening). In so doing the vein thus makes a comparatively weak area

lies in close proximity to the femoral canal, and presents a line of least resistance to any hernia which may penetrate the canal and by growth seek a direction for expansion.

Fossa Ovalis, (Saphenous opening). This ovoid opening lies in the upper and medial part of the thigh, a little below the medial end of Poupart's ligament. It is a deficiency in the fascia lata due to the penetration through it of the saphenous vein. The superior, and also superficial margin of the fossa derives from the superficial portion of the fascia lata which reflects from the tubercle of the os pubis downwards and laterally in a sweeping curve called the Falciform Margin. This falciform margin overlies and is adherent to the anterior layer of the femoral sheath.

The inferior margin of the opening is formed by the deeper layer of the fascia lata, which, when traced upwards overlies the pectineus, adductor longus and gracilis muscles. It then passes deep to the femoral vessels, closely attaches to their sheath, and ultimately continues as the iliopectineal fascia on to the pecten pubis.

Thus it is seen that the superficial layer of the fascia lata lies in front of the femoral vessels, and the deeper layer behind. The fossa ovalis lies between the two, forming a deficit which is overlaid by a thin fascial

covering derived from the superficial fascia, and known as the fascia cribrosa (cribriform fascia).

Gimbernat's Ligament (Lacunar Ligament). This is that portion of the aponeurosis of the external oblique muscle which is reflected backwards and laterally from the medial part of the inguinal ligament, and attaches to the pecten pubis. When the body is erect it has an almost horizontal disposition.

The ligament is triangular, somewhat larger in the male, and measures about three fourths of an inch from apex to base. The base is directed laterally, is concave, thin and rigid, and forms the medial margin of the femoral ring. See Figures 85 and . The apex corresponds to the pubis tubercle.

The posterior margin of the ligament attaches to the pecten pubis and continues with the pectineal fascia. Anteriorly it blends with the inguinal ligament.

The lacunar ligament has two surfaces, directed upwards and downwards respectively.

Ligament of Cooper. This extends as a strong fibrous band along the pecten pubis, laterally from the lacunar ligament. It is a posterior relation of the femoral vein and sometimes also of the canal.

The inguinal ligament, fascia transversalis, conjoined tendon, reflected inguinal ligament and spermatic

cord with related structures may all be concerned in the surgery of the femoral herniae, but have been discussed in Chapter 6.

Anatomy of a Femoral Hernia. Any protrusion of peritoneum through the femoral ring follows the line of least resistance. It receives an investment from the extra-peritoneal fascia and fat, is overlaid at the fundus by the femoral septum, and descends through the femoral canal so far as the fossa ovalis. It is then deflected in a superficial direction by the attachment to the margins of the fossa ovalis. The sac therefore directs forwards, pushing before it the cribriform fascia to emerge superficial to the deep fascia of the thigh (fascia lata). It again changes direction to pass upwards over the inguinal ligament and lower part of the anterior aspect of the aponeurosis of the external oblique, being overlaid by superficial fascia and skin.

The coverings of the hernia are from within out:

1. Peritoneum.
2. Extra peritoneal fat and fascia.
3. Femoral Septum.
4. Femoral Sheath.
5. Fascia Cribrosa.
6. Superficial Fascia.
7. Skin.

The hernia almost invariably carries in front of it a mass of fibro fatty tissue forming a properitoneal lipoma.

It is important to remember two facts in connection

with the covering of a femoral hernia. First the attenuated femoral septum with the cribriform fascia, may be mistaken at operation for the sac, and the fatty tissue deep to it for omentum. Secondly the "pseudo" sac mentioned is separated from the true sac, by a thick layer of fibro fatty tissue, derived from the extraperitoneal fat. The true sac lies embedded in a thick fatty bed and overlaid by at least one definable layer of fascia.

Shape of the Sac. The sac resembles a collar stud. The unyielding femoral ring causes it to have a narrow neck and mouth. The comparatively unyielding nature of the femoral canal confines its increase in size in a lateral direction, but when it gains the superficial aspect of the thigh it enlarges in all directions, though the neck remains in conformity with the shape of the canal and ring. Figure 86.

Differences in the Two Sexes. The femoral ring is larger in the female and tends to become even larger after repeated pregnancies.

Anatomical Points of Potential Constriction of the Sac.

1. The junction of the falciform margin of the fossa ovalis with the free edge of the inguinal ligament.
2. The margins of the fossa ovalis.
3. The unyielding margin of the lucunar ligament.
4. Thickened peritoneum at the neck of the sac.

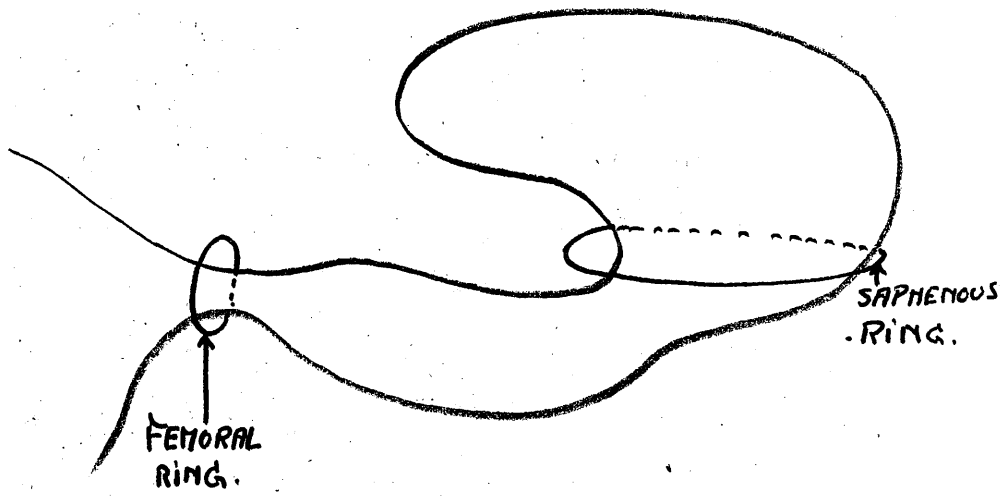

Figure 86.

Shape of sac in fully developed adult femoral hernia.

Points of Exit of the Sac. Femoral hernia usually descends between the femoral vein and Gimbernat's ligament,[4.] but it may also descend above the femoral vessels and slightly external to them.[5.]

Hour-Glass Sac. An hour-glass sac may have two or more loculi emerging from the femoral ring, through Gimbernat's ligament, on the surface of the pectineus muscle, or through the cribriform fascia or beneath it.

Double Sacs. It is probable that double sacs are formed by reduplication of a peritoneal pouch into an unobliterated congenital diverticulum. More rarely two congenital diverticula may pass through the femoral ring. Double femoral herniae are rare, although several have been reported.[6.] Scott operated on a woman, aged thirty-seven years, with two femoral hernias on the right side. He called attention to the danger of wounding the femoral vessels when one hernia is lateral to them.

Frequency on the Right and Left Sides. Femoral hernia is more frequent on the right side in both sexes. Inguinal hernia occurs with nearly equal frequency on both sides in women, while femoral hernia is nearly twice as common on the right.[7.] Kotzareff reported upon 65 cases in women; of these 46 were right sided and 19 left sided.

Frequency of Femoral and Inguinal Hernia in Men. Of 8,655 cases of inguinal and femoral hernia in Italian soldiers

reported by Perassi,[8] 8,563 were inguinal and 92 femoral.

Femoral Hernia Associated with other Varieties. Femoral hernia may be combined with one or more hernias in other regions. It is most frequently associated with inguinal. In 10,000 cases Berger[1] found femoral and inguinal combined in 222; of these 203 were in males, and 19 in females. In 87 cases there were double femoral hernias. In my series of 438 inguinal herniae, 3 were associated with femoral of the same side.

Cruro-Scrotal Hernia. Rarely inguinal hernia descends into the femoral region instead of the scrotum. It may follow an ectopic testis which has descended into the crural region. Often the cause is an anatomical abnormality of the spermatic cord. Giusti[9] reported a case of inguinal and femoral hernia with a single bilocular sac.

I had two examples of cruro scrotal hernia in males, and both were operated upon within the same week. One was diagnosed before operation as a femoral and the other as a small indirect inguinal. In neither case were the testicles misplaced or undescended. The same anatomy was present in both patients. The inguinal canal was normal in its upper half, but, the spermatic cord instead of passing through the external ring to enter the scrotum, passed deeply through the fascia transversalis and entered the femoral ring. It traversed the femoral canal and then

curved medially and upwards to enter the scrotum. Both cases were on the left side and the patients were otherwise normal. In both the sac emerged through the internal inguinal ring. The first passed through the femoral canal, yet remained within the cord and did not expand upwards towards the inguinal ligament as does a typical complete femoral hernia. In the second the sac did not enter the femoral ring but remained confined to the inguinal canal.

Ferguson[50] reported a similar example.

Eccles[10] reported a case of cruro-scrotal hernia in a man, aged fifty-three years, in which a right inguinal hernia descended along the thigh to a point three inches above the patella.

RARE VARIETIES OF FEMORAL HERNIA.

1. External Femoral Hernia.[11] External femoral hernia passes into the thigh below Poupart's ligament, and lateral to the deep epigastric artery. It is almost always associated with an inguinal hernia of the same side. External femoral hernia may enter the ring lateral to the external femoral hernia may enter the ring lateral to the external iliac artery and spreads out in Scarpa's triangle anterior to the vessels.

2. Hernia through Gimbernat's Ligament (Hernie de Laugier: Hernie Crurale Interne.[12, 13] Hernia through Gimbernat's ligament was described by Laugier, in 1833. Here the sac emerges between the fibres of Gimbernat's ligament. It is usually small and lies more internal than the ordinary variety.

3. Pectineal Hernia (Cloquet's Hernia). Pectineal hernia enters the femoral canal, penetrates the aponeurosis of the pectineus muscle and remains between it and its aponeurosis to simulate an obturator hernia. The condition is probably due to an abnormal insertion of the pectineal fascia.[14.]

4. Retrovascular Hernia. The sac of a retrovascular hernia follows the femoral sheath downwards and behind the vessels.[15.] Serafini reported a very rare example where the sac descended behind the femoral vessels, within the sheath of the femoral vein. Diagnosis was confirmed at autopsy.

5. Prevascular Hernia. In prevascular hernia the sac is situated in the femoral sheath but in front of the vessels.[16.] Narath reported 6 cases of traumatic prevascular hernia following reduction of congenital dislocation of the hip, with which it is often associated.

ETIOLOGY.

Saccular or Congenital Theory. The congenital origin of

femoral hernia is generally accepted to-day. The hernia enters a preformed pouch or diverticulum which has failed to become obliterated.

The reason for the presence of this preformed sac are uncertain.

In addition to its presence, precipitating factors are also required. These are as for other herniae, strains due to any cause, visceroptosis, repeated pregnancies, debility, muscle weakness, constipation, chronic cough and so on.

Infants and Children. Femoral herniae are rare in young people.

The fact that femoral herniae are uncommon in young people seems to me to argue against the congenital theory of origin, and to support the argument that the anatomy of the area is the main predisposing factor.

Anatomic Causes. The conditions which predispose to the development of femoral hernia are: a preformed sac; prominence of the peritoneal depression overlying the femoral ring; absence of the lymph gland within the canal; and a patulous saphenous opening, or large compressible femoral vein. Joessel[17.] believed that an open femoral ring is the most important factor.

Other predisposing causes are: increased intra abdominal tension due to obesity ascitis or tumours and,

in the aged, relaxation of the femoral ring.

It is generally believed that occupations requiring a continuous stooping position predispose to hernia formation.

Femoral Hernia Developing After Operation for Inguinal Hernia.

Inguinal hernia may occur after an operation for femoral hernia. The inguinal hernia is usually indirect when the femoral hernia has been operated on by the femoral route; and direct, when the femoral hernia has been operated on by the inguinal route.

When femoral hernia follows an operation for inguinal hernia, it is probably due to the pulling upward of Poupart's ligament by the deep sutures of the inguinal repair which increases the size of the femoral ring. In operating for inguinal hernia it is sometimes advisable to stitch the conjoined tendon to Cooper's ligament when Poupart's ligament is lax or deficient, to minimise risk of secondary development of femoral hernia.

18.

In two cases operated on by myself for small indirect inguinal hernia, and where no repair was performed, femoral hernia developed some months later.

It is doubtful if this can properly be termed a recurrence but in one case the original operation was done by someone other than myself and a Bassini repair performed. A year later I operated for recurrent indirect inguinal hernia and did a repair by means of a Gallie fascial graft.

Six months later the patient appeared again and this time with a femoral hernia which I again operated upon and this time used a whole skin graft. Nine months later he re-appeared with another hernia on the same side, the third recurrence. No operation was carried out, but clinically the condition seemed to be a diffuse direct inguinal hernia. He was fitted with a truss. The patient was a chronic bronchitic, and co-operated very badly during the post-operative period, taking considerable liberties in bed, and rising on the third day after his skin repair in order to visit the toilet.

In a woman, I performed in August 1944 a bilateral repair for double direct inguinal herniae. In January 1945 she developed a right femoral hernia, which in May, 1945 was the size of a small hen's egg and presented all the characteristics of a femoral hernia.

Symptoms and Signs.

Functional Symptoms. These vary but little from the characteristic symptoms of inguinal hernia, but occasionally there may be complaint of numbness, or sense of weight in the affected thigh.

19.

Local discomfort may be more severe than in the complete inguinal hernia.

Objective Signs. The swelling presents as a small globular mass just below the inguinal ligament. The mass varies in

size up to an egg and, when reducible has all the characteristics of an external abdominal hernia.

It should be noted that the swelling is in the thigh, well lateral to the pubic tubercle and may extend upwards to overlap the inguinal ligament from below.

Examination of the inguinal canal will demonstrate that the swelling is not within it, and palpation of the cord in the upper scrotum will reveal an absence of thickening unless some other condition such as varicocele or inguinal hernia coexists.

CONTENTS OF SAC.

The contents of the sac are most commonly omentum, bowel small or large, the appendix, the urinary bladder or rarely a Meckel's diverticulum.[49.]

Omentum is almost invariably present. Its presence is usually associated with that of bowel. Occasionally the ovary, tube, or even uterus may be within the sac.

Sweet[23] has recorded a Meckel's diverticulum which became incarcerated. He was able to find only fourteen other similar cases in the literature.[24.] Ludbrook reported two cases closely similar, one an acutely inflamed appendix within a femoral sac, and the second an inflamed Meckel's diverticulum. In a total of 295 cases of hernia of the urinary bladder reported by Eggenberger,[24.] Brunner[25.] and Thomas[26.] 27% were femoral.

Differential Diagnosis.

The differential diagnosis is from other types of hernia saphenous varix or cold abscess.

Inguinal Hernia. This has been already dealt with in detail. The landmark of importance is the pubic tubercle, which, in femoral herniae can be palpated well medial to the swelling. Inguinal herniae may also be found lateral to it, but femorals are considerably more so.

If the condition is reducible, confusion is less probable but irreducible inguinal hernia may be difficult to differentiate from femoral hernia, especially in the female.

20.

Saphenous Varix. Boinet first distinguished between saphenous varix and femoral hernia in 1836. The salient differential points are:

1. A saphenous varix disappears when the patient lies down, and does not require manual reduction.
2. It appears when the patient stands up, but may be prevented from so doing by making pressure over the femoral vein.
3. On coughing there is a characteristic thrill on palpation of the swelling contrasting with the impulse of a hernia.
4. On auscultation of a varix there is a characteristic bruit audible as a continuous hum.
5. When the swelling of a varix disappears it does so without a gurgle.

Incarceration of a femoral hernia may be confused

with a varix when the latter is complicated by phlebitis. Haberern[21] described an example in an elderly woman who had worn a truss for nearly four years because of a supposed femoral hernia. Symptoms of incarceration compelled operation. The seat of trouble was found to be a large thrombosed varix, and symptoms cleared up after it had been excised. Haberern in his paper reviewed other similar cases.

A similar example was recorded by Noehren[22] in 1911. His patient however, suffered also from a mass within the pelvis considered to be a pelvic peritonitis. It was considered, after removal of the thrombosed varix which had simulated strangulation of a femoral hernia, that the pelvic lesion was due to an extension of the thrombosis into the external iliac vein plus a periphlebitis.

Cold Abscess. Cold abscesses may present in the thigh in relation to the saphenous opening. They are not always reducible, but may rarely do so with a gurgle. There is no expansile impulse on coughing, fluctuation can be detected unless the abscess is very tense, and often a mass may be palpated within the pelvis in relation to the psoas. The size of the abscess is not influenced by exercise, and only exceptionally by posture, but it tends to increase progressively. There is often evidence of tuberculous pyrexia, but the focus of infection may not at first be easy

to determine. I lately saw a boy of eighteen with such a swelling overlying the femoral triangle. Diagnosis of cold abscess was made and the swelling aspirated. One pint of pus was withdrawn and on examination tubercle bacilli were cultured from it. Full radiological examination of the spine and sacroiliac joints failed to demonstrate a bony lesion. One month later the examination was repeated and stereoscopic films were taken. Again with a negative result. The abscess by this time had required incision and drainage.

One month later repeat radiographs demonstrated a large cavity within the right sacroiliac joint with extensive tuberculosis bony destruction.

Lipoma. Lipoma in Scarpa's triangle (femoral triangle) may be confused with irreducible femoral hernia. The lipoma is more often lateral to the saphenous opening, somewhat below it, and gives no impulse on coughing. It is painless and has often a characteristic margin and contour. Being attached to the overlying skin it may be pulled up by traction on the skin.

Aneurysm of the Femoral Artery. This condition is not common and should not be confused with an irreducible hernia. The aneurysm has a pulsation synchronous with the radial pulse and a loud bruit on auscultation.

Cysts, Neoplasms and Psoas bursae. These swellings are rare and should not give confusion after careful examination. Rarely they may be difficult to distinguish from irreducible hernia.

PROGNOSIS.

The prognosis of the uncomplicated case is good with operation. The untreated case is subject to a grave risk of strangulation which is approximately ten times more common in femoral than in inguinal herniae.

The only safe procedure is operation. It is difficult to control the swelling by mechanical means, and the injection method would not seem very applicable owing to risk to the related vessels.

Prognosis as to end result after operation varies, like all hernia results, with different clinics, and after different operation, but they are on the whole good and better than those for inguinal cases. The published figures vary from 0-30% recurrence. A fair estimate is probably 10%.

The prognosis after strangulation is worse, and follows the rules governing other cases, being more grave with passage of time after onset, the advancing age of the patient, and the viscus in the sac.

COMPLICATIONS.

Femoral Hernia is subject to the same complications as any other, but enjoys a particular liability to strangulation. Obstruction, Incerceration, Contusion and Strangulation are clinically recognisable on the same symptoms and signs observed in inguinal cases. There are no characteristics peculiar to the femoral region.

STRANGULATION.

Strangulation is frequent in this type of hernia because of various anatomical peculiarities of the area which determine the dimensions of the neck and mouth of the sac and the course of the hernia. They are:

1. The unyielding nature of the femoral ring.
2. The narrow femoral canal, which means that any viscus passing through it is unable to expand in a circumferential direction, and is liable to constriction of its blood vessels with increase in size.
3. The frequent presence of omentum leading to adhesion formation and irreducibility.
4. The alterations in direction taken by the sac and its contained viscus, which means that the viscus is kinked twice upon itself. It descends only to be deflected to a right angle in order to traverse the foramen ovale (saphenous opening) and, having done so is again deflected upwards towards the inguinal ligament owing to the attachments of the fascia lata in the area of the hernia.

The actual constricting mechanisms are:

1. The fibrosed neck of the sac.
2. The edge of the lacunar ligament.

3. The edges of the foramen ovale, especially the falciform margin.

4. The upper edge of the femoral ring. This is virtually a portion of the inferior edge of the inguinal ligament.

Blakeway[49] has written that the most important and frequent of these mechanisms is that due to a fibrosed sac neck and emphasised the importance of cutting this rather than the lacunar ligament when operating upon strangulation. Souttar[50] endorsed this view.

The symptoms and signs of strangulation do not vary from strangulation elsewhere.

It is more common in women than in men owing to the increased frequency of femoral hernia in that sex.

Strangulation of Cloquet's Hernia has also been described[51] but is rare. It does not vary in symptomatology from the usual variety.

TREATMENT OF FEMORAL HERNIA.

Mechanical Methods. Where operation is contraindicated or the patient refuses permission, small hernias may be controlled by a truss.

A femoral truss is similar to an inguinal one save that the pad is situated at a lower level attached to a downward prolongation of the truss itself. The pad should exert pressure directly backwards. Figure 87.

Figure 87.

Truss for adult femoral hernia.

The method of measuring for a truss is as for the inguinal type, but the aparatus is more difficult to wear from the patients' point of view and is less comfortable. Patients may complain of interference with movements of the lower limb on the effected side. Oedema of the limb may follow if the pad exerts pressure on the femoral vein.

No irreducible case should be fitted with a truss.

Injection Treatment. This is spoken of warmly by several writers including Watson and Meyer. It is one which demands much experience and has already been discussed, Chapter 12 . In my view operation is likely to yield better results in the hands of all but those who have perfected themselves in the injection technique. It may be remembered that Meyer found with his first few hundred cases an appreciable recurrence rate after injection therapy. It was only after wide experience that his statistics improved. It follows on the admission of one of most expert exponents of this method that good results follow only upon much practice, and it would appear to follow logically that the method in the hands of a novice is unlikely to be highly successful. Operation on the other hand when performed by any surgeon of experience in general surgery gives fair results whilst the injection method in the hands of the same person may not, unless he has applied himself diligently to a complete study of, and

gained a mastery of, the injection technique.

Operations for Femoral Hernia.

Many operations have been devised, over 70 in fact,[52.] and many modifications of procedure adopted by different surgeons, though perhaps to a lesser extent than in the inguinal cases. These vary from the simple Bassini to the complicated bone periosteal flap plastics of Trendelenburg and Kraske.[53.]

The ideal operation is designed to remove the sac, obliterate the femoral canal at a high level and that without prejudice to the integrity of the inguinal canal or rings.

Many methods applicable to inguinal herniae have been used in the cure of femoral cases, and the evolution of the treatment of the two conditions are closely connected. No purpose is to be gained, other than a confusion of the issue, in listing here the many operations devised. Only the more important methods are outlined.

There are three possible approaches to the sac, trans-inguinal, trans-abdominal and trans-femoral. A fourth, or combined femoral abdominal may be included. In each case the intention is to remove the sac, to obliterate the canal, and to avoid damage to other important structures.

(1) TRANS INGUINAL METHOD.

The incision is as for exposure of the inguinal canal and deepened to expose the aponeurosis of the external oblique and the external ring. The skin is undercut below to expose the inferior margin of the inguinal ligament with the properitoneal mass of fat containing the femoral sac relating to it.

This mass is seized in mosquito or tissue forceps and incised. The individual layers covering the sac are separated and the sac exposed. The neck must be freely denuded of all attached fascia and fat. This may not be easy. When it has been performed the fundus is steadied by mosquito forceps and carefully opened. Any viscus within is reduced or, if adherent, dealt with in the usual way, separated and reduced. Omentum may more conveniently be excised, and especially if inflamed or fibrosed, this is indicated.

The sac neck is transfixed and ligated. A small clamp is applied just distal to the ligature and the redundant portion excised.

The upper margin of the wound is then retracted gently upwards to expose the anterior wall of the inguinal canal. This is opened in the usual way to expose the cord. The margins of the external oblique aponeurosis are then clipped with small forceps and retracted to expose

the conjoined tendon, the cord and the inguinal ligament.

The cremaster fascia is incised in the line of the cord and the cord lifted up from its bed. It is then retracted either by a swab or Morant Baker forceps in order to give a clear view of the posterior wall of the canal.

The deep epigastric vessels are now identified and a small incision made in the fascia transversalis about one quarter of an inch proximal to, and parallel to the inguinal ligament. The upper margin of this incision is retracted upwards and the areolar tissue which is exposed cleared away by blunt dissection to expose the neck of the sac.

The forceps controlling the ligated stump of the sac from below are now removed and the sac remains withdrawn into the inguinal canal through the femoral ring. The stump is carefully stripped away from any attachments to the bladder and dissected up to as high a level as possible. The Parietal peritoneum PROXIMAL to the neck of the sac is then transfixed in two directions by a stout ligature and tied off. The redundant portion of sac is removed. This step ensures excision at as high a level as possible. The canal may then be obliterated from above by one of several methods, the posterior wall of the inguinal repaired and if deemed necessary a plastic repair of the posterior wall of the inguinal canal performed.

Methods for closing the femoral canal are considered below.

(2) TRANS ABDOMINAL APPROACH.

The incision is either a subumbilical vertical or transverse, or Pfannensteil's. The extraperitoneal tissues are exposed but the abdominal cavity is not opened.

The patient is placed in a moderate Trendelenburg position and the operator stands on the side opposite that of the hernia.

When the peritoneum has been exposed it is stripped upwards and packed out of the operating field.

Cheatle[34, 35] has strenuously emphasised the importance of correct placing of retractors. Two are used. They are long, slender and blunt hooked. The first is inserted to pull the abdominal wall downwards, forwards and outwards, and its hook should reach the level of the deep epigastric vein. The second retractor pulls the abdominal wall outwards. The peritoneum is then dissected and pushed laterally to expose the iliac fascia. At this stage in the operation the neck of the sac can usually be identified entering the femoral ring; having been identified, it is gently pulled through the canal until the fundus has appeared. It may then be excised at a high level.

Irreducible enteroceles are unsuitable for this type

of operation but omentoceles may be dealt with satisfactorily. The method is most applicable to reducible cases.

Before closing the incision the canal may be closed by one of the several methods shortly to be described.

Support for this method has also been given by La Rogue.[54]

(3) TRANS FEMORAL ROUTE.

The incision is either oblique, one inch below and parallel to the inguinal ligament, or vertical over the swelling.

It is deepened to expose the fatty mass containing the hernial sac. This is carefully incised and each layer of tissue dissected up to as high a level as possible. The sac may be difficult to find, and that especially if it is small and thin and surrounded by much fat, as it frequently is.

It may be identified when reached, by its smooth white opaqueness which contrasts with the appearances of the other fascial layers overlying it.

When the sac has been found it should be grasped in small tissue or artery forceps and traction exerted in a downward direction. As this is done the neck gradually comes into view overlaid by a layer of fibrous tissue of

varying thickness and strength. These fibrous strands are carefully incised circumferentially around the neck and with the help of some blunt dissection and continued traction, the parietal peritoneum will be pulled into view.

The entire sac should then be denuded of attaching fat or fascia the fundus steadied in artery forceps and incised. Its contents are reduced and the parietal peritoneum ABOVE THE NECK transfixed in two directions, ligated and the redundant sac excised. When released, the stump should retract rapidly back through the canal into the extraperitoneal tissues, but only when it has been efficiently freed. If it does not spring back itself it should be gently persuaded through the canal and disposed in the correct position.

As in other cases the femoral ring may be closed by one of several methods.

METHODS OF OBLITERATING THE FEMORAL CANAL OR RING.

Roux' Method.[25] Here the inner end of Poupart's Ligament is fastened down to the pubic bone by a U-shaped metal staple driven into the bone through the canal.

This method has little to commend it as there is a real risk of damaging the vessels, or introducing sepsis,

of traumatising the inguinal ligament which may later tear out of its metal attachment, and finally of causing osteomyelitis of the pubis. In any case it is common to find the metal peg working loose after a few months and requiring removal by another operation.

This method is now obsolete and has given place to a host of safer procedures.

Purse String Suture. This has been advocated by Marcy[26.] Tricomi,[27.] Wood,[28.] Bottini,[29.] Coley and Cushing.[30, 48.] [31.]

The purse string includes the Inguinal Ligament, the sheath of the femoral vessels, the pectineus muscle and fascia, and the edge of the lacunar ligament. It terminates by passing again through the inguinal ligament near its point of entrance.

When the suture is tied tightly the canal is fairly well obliterated. The dangers lie in damage to vessels and tearing of the inguinal ligament when the attempt is made to force it down on to the pectineus.

Interrupted Sutures. Bassini[32.] advised interrupted sutures passed between the inguinal ligament and the pectineus fascia. This is safer than the purse string method in that danger to vessels is less, but closure is less efficient.

Lockwood,[33.] Marchetti,[44.] de Lucci and Salinari[45.] have advocated the same principle.

Gallie's Method. Here a strand of fascia lata is darned back and forth between Cooper and Poupart's ligaments commencing at the pubic spine and extending laterally so far as the femoral vein. In my view this is the best of the methods attempted and gives effective closure of the ring which is the most important part. It virtually forms a new femoral septum over the ring and renders entry of peritoneum improbable.

Damage to the vein is unlikely if due care be taken in inserting the sutures.

Wyllis Andrews Method.[36.] Here the upper leaf of the aponeurosis of the external oblique muscle is brought down behind the cord and sutured with the conjoined tendon to Cooper's ligament and the overlying pectineus muscle and fascia.

Halsted's rectus sheath method is similar, only a flap of the rectus sheath is used instead of the external oblique.

These two operations are, in my view, inferior to the Gallie method and have a fault in that they interfere with the inguinal canal. One object of operation for femoral hernia is to traumatise it as little as possible. They also have the disadvantage of attempting to unite fascia or aponeurosis with pectineus muscle by side to side union.

37.
Dickson's Method. Fascia Transversalis is sutured to the pectineus muscle and fascia by interrupted sutures extending from the pubis laterally to the femoral vein.

This operation may also weaken the posterior wall of the inguinal canal from that point of view is less efficient than the Gallie method, besides giving a less powerful repair.

38.
Blake's Method. Here the suture penetrates the external oblique just lateral to the pubis, enters the femoral ring and passes through Cooper's ligament. It passes through the canal and is reintroduced into the canal from below, again taking a bite of Cooper's ligament on the lateral side of the femoral ring and back through the external oblique from deep to superficial. When the suture is tied the anterior wall is approximated to the posterior.

There is a risk of damage to the vein with this stitch, and also of tearing of Poupart's ligament when attempting to force it down on to the posterior wall of the canal.

39.
Kummer's Method. This is similar to Blake's but silk gut is used for the U type of stitch. It is advised that the stitch be used doubled.

This has the same disadvantage as Blake's method plus the added disadvantage of utilising unabsorbable

suture material.

This last will not be a disadvantage in the eyes of those who sponsor buried non-absorbable sutures, but for antagonists to the method it is an objection of consequence.

Moschocowitz' Method.[40] The internal femoral ring is closed by suture of the inguinal ligament to the pectineus muscle and Cooper's ligament, and to the periosteum of the pubis by either a purse string or interrupted sutures.

Pedunculated Pad of Fat Method.[41] Chaput has advocated closing the canal with a pedunculated pad of fat hinged over the pubis and inlaid into the femoral ring. It is then anchored by stitches to the ligaments of Gimbernat and Cooper.

Under such circumstances fat is inclined to atrophy and it is improbable that any other than union by filmy adhesions will take place with the points of supposed anchorage. The method in my view has little to commend it.

Celluloid Filigree Inlay.[42] Thomson has used, and claimed to have success by the method, a small triangle of perforated celluloid inlaid into the femoral ring and cut at operation to fit each patient. The shape is made to conform to that of the internal femoral ring. Irritation of, and later ulceration of the vein is possible, and the

method has the objections common to all filigree types of repair.

43.

Polya's Muscle Plug. Polya advised the inlay of the sartorius muscle into the femoral canal. The muscle is severed, the stump drawn into the canal and sutured to the pectineal fascia. This seems an unnecessarily mutilating operation and entails an extensive incision in the thigh. The saphenous vein has to be ligated and cut, and the ultimate fate of the muscle stump is uncertain. Atrophy is possible.

Is Closure of the canal or Femoral Ring Necessary? If the theory of femoral hernia being congenital in origin is correct, it logically follows that cure should involve excision of the congenital sac at a high level and that no more need be done save in those cases where the ring and canal have become distended by long continued pressure of a large hernia.

The presence of a small sac, normal ring and normal or slightly distended canal should contraindicate any plastic repair. Several reasons may be postulated to support this view.

1. Simple excision of a small sac in these cases is simply restoring the femoral ring and canal to their normal state.

The only possible difference from the normal anatomy

lies in the weakening of the femoral septum. This structure is not at the best of times very powerful. Its presence alone does not prevent the development of hernia. Other factors are also involved.

2. Statistical results show that recurrence rate after such a conservative operation compare with those of other methods in these small cases.

3. The cause of such herniae is primarily the presence of the congenital sac. Excision of such a sac should cure the hernia provided no stretching of the area has occurred.

As arguments against performing a plastic repair, or making any effort to close the structures may be listed:

1. Any effort to approximate the inguinal ligament to the underlying pectineus fascia imposes a strain on the fibres of the ligament which may tear. In consequence the femoral ring and canal are not obliterated, and in addition the inguinal ligament is weakened.

2. Any effort to approximate the anterior and posterior walls of the ring or canal is liable to cause pressure on the femoral vein with subsequent oedema of the leg. This will not happen unless the narrowing is carried close to the vein, but, unless it is carried to a point immediately lateral to the vein obliteration of the supposed danger spot will not have been achieved.

3. It is not anatomically possible to obliterate the ring or canal by utilisation of the structures relating to the part, either by pursestring or interrupted sutures. Obliteration can effectively be achieved only by using some form of graft of living tissue such as fascia or skin.

POINTS IN OPERATIVE TECHNIQUE.

Incision. This may be one of several, but, in each case it should be generous, and more so than for an inguinal hernia. In the transinguinal approach it should be one half to one inch above the inguinal ligament, and in the trans femoral approach the same distance below, or alternatively vertically over the swelling for a distance of three or four inches.

In small herniae the centre of the swelling should be approximately at the centre of the skin incision. The vertical type of trans femoral incision is made parallel to and just medial to the femoral vessels.

It is sometimes a convenience to make a curved incision. This is especially so in obese subjects. In vertical incisions the convexity should be outwards, and in those parallel to the inguinal ligament the skin flap should hinge on the fold of the groin.

Further points of technique are best discussed according to the type of operation.

Trans Femoral Operation.

When the incision has been made and deepened through fat to expose the fascia, certain structures must be identified.

Long Saphenous Vein. The termination of this vein is approximately one and a half inches below the inguinal ligament and it must not be wounded. If it does require to be ligated no serious damage will befall the patient provided the communications between the superficial and deep veins are patent. If it is accidentally wounded the haemorrhage may be annoying before the vessel is cleanly exposed and ligated.

Saphenous Opening. The margins of the wound must be retracted to expose the saphenous opening and the vein carefully guarded. The hernia with its properitoneal pad of fat will overlie this opening and must later be reduced through it.

In obstructed or strangulated cases the point of constriction is sometimes the flaciform margin or upper and lateral margin of the opening. In such cases any incision into the fibrous band must be made with regard to its relation to the underlying deep vessels.

Femoral Vein and Artery. These vessels are readily palpable, especially the artery.

If the hernia is reducible it should be reduced and

the vessels exposed and retracted to bring into view the pectineus muscle and fascia. In irreducible cases it may be impossible to identify any landmark other than the artery which is detectable by its pulsation.

Properitoneal Fat and Superficial Fat. These fatty layers separated by the fused layers of the fascia cribrosa and septum crurale must be carefully dissected through and neither confused with omentum. They should be carefully incised and cleared from the included sac until that structure has been clearly identified. All redundant fatty and fibrous tissue must be cleared away from it right up to its neck and as high as the femoral ring.

In performing this dissection the presence of the femoral vessels on the lateral side must be kept constantly in mind.

Opening of the Sac. The sac may be very thin. If so it may readily tear when being cleared. If it is thick the possibility of a sliding hernia of the large bowel or bladder must be considered.

The sac must be incised on the outer aspect lest mishap befall an adherent bladder. The incision should be at the fundus and generous enough to permit efficient exploration of its interior.

Contents of the Sac. These must be reduced, and reduced

without trauma. If irreducible, any intrasaccular adhesions must be separated as in any other hernia.

The bladder is not infrequently present. It must be gently detached, any intrasaccular diverticulum excised, and the bladder closed in the conventional fashion. Such diverticula usually have a very narrow pedicle and opening into the parent organ.

Sliding hernia of the large intestine may be recognised. It must be dealt with as in any other type of sliding hernia, see Chapter 19.

Disposal of the Sac. The sac must be retracted downwards, all adherent fascia and fat incised and removed circumferentially to enable the parietal peritoneum from which it derived, to be exposed. The sac is twisted several times, and transfixed in two directions at right angles to one another as already described. The ligature is tied and the redundant portion of sac excised about one fourth of an inch distal to the ligature.

Closure of the Canal or Ring. When the sac has been excised and the ligated stump returned through the canal to the extra peritoneal tissues, in large and moderate sized cases some method of closing the ring must be adopted. In either the pursestring, interrupted suture, or fascia methods certain technical points deserve note.

Needles. These should be full curved and round bodied. They are most conveniently handled by needle holding forceps.

Each bite of tissue, with the exception of the fascia over the medial aspect of the femoral vein, should be generous. If the tissues are not sufficiently deeply transfixed by the ligatures the stitches will be apt to tear out.

Any stitch through the inguinal ligament should be made with regard to the possibility of tearing of its fibres.

Suture Material. Chromicised cat gut is suitable. Any suture used must be sufficiently powerful to stand up to the strain of approximating the edges of a fairly rigid structure, and yet the suture must not be so thick as to tear the fibres of the inguinal ligament when tied.

Saphenous Opening. If any attempt is made to close the femoral ring, which is the proximal end of the canal, then it is logical to reinforce also the distal end, namely the saphenous opening. This cannot be entirely closed, but it may be narrowed by some interrupted sutures inserted with attention to the position and course of the saphenous vein.

Subcutaneous Tissues. These should be closed by a running suture of fine cat gut before approximating the skin edges.

Trans Inguinal Approach.

When the anterior aspect of the aponeurosis of the external oblique has been exposed, the inferior margin of the incision is reflected downwards to identify the hernial swelling surrounded by fat and the saphenous opening. The first steps of the operation have been described in the femoral operation, up to excision of the sac.

The Inguinal Canal is then opened, the cord lifted up from its bed, and the posterior wall of the canal exposed.

Incision through the Fascia Transversalis. The fascia transversalis is now incised parallel to the deep epigastric vessels and to their inner side. This incision is made to overlie the neck of the sac and exposes a mass of areolar tissue in which the neck is embedded.

The deep epigastric vessels may be in the way of the incision and require division between ligatures. Often it is enough to retract them laterally. Their integrity is of value in minimising risk of postoperative direct hernia.

Obstructed and Incarcerated Cases. The peritoneum may be opened proximal to the mouth of the sac in irreducible cases, and an attempt made to effect reduction by gently

manual traction upon the affected viscus. This may also cause reduction of the sac and invert it thus facilitating separation of adhesions. In reducible cases the sac will already have been excised in part from below.

The peritoneum is not closed if it has been opened and the stump of the sac pulled through or persuaded through the femoral canal from the thigh. Any remaining redundant portion is excised by transfixing and ligation in the usual manner.

The transinguinal approach makes excision of the sac at a very high level quite easy.

Closure of the Ring and Canal. The areolar tissue is well retracted with the femoral vein laterally and the opening of the femoral canal identified from the abdominal aspect. The margins of the ring and floor of the canal should be well exposed by careful dissection to make as ideal an operative field as possible before closing the ring by one of the various methods outlined.

All sutures must be placed under direct vision and care taken to avoid damage to the several important relating structures.

Closure of the Posterior Wall of the Inguinal Canal. The closure of this wall must be efficient or there will be a real risk of post operative direct hernia. The fascia transversalis must be closed carefully and if necessary,

further support can be given by a fascial or skin inlay graft. This is inlaid as for the ordinary repair of direct inguinal hernia described in Chapter 14.

Spermatic Cord. This structure has not been opened, but merely retracted. It is now permitted to return to its normal position.

Anterior Wall of Inguinal Canal. The external oblique aponeurosis is closed by a continuous suture, taking care not to include the ilioinguinal or iliohypogastric nerves.

The skin edges are then approximated in the usual fashion.

Trans Abdominal Approach.

No points of special importance arise other than to lay an emphasis upon the need for efficient retraction of the incision in order to get a good exposure of the abdominal end of the femoral canal.

The operation is unsuitable for irreducible cases.

OPERATIVE RISKS.

Injury to Blood Vessels. The Femoral vessels, the Deep Epigastric vessels and the aberrant obturator artery may all be wounded.

Aberrant obturator artery: this vessel is met with in only a small percentage of cases.

Injury to Bladder. If the sac is thick, covered with ~~the~~ lemon coloured fat, or by numerous small blood vessels, the presence of bladder should be suspected. The organ is usually on the inner aspect of the sac, and may be firmly attached to it. This attachment, if present, must be freed in order to ensure high retraction of the ligated stump.

OPERATION FOR STRANGULATED FEMORAL HERNIA.

This varies but little from the standard approaches and operations for femoral hernia, and, in the disposal of the affected bowel from that in any other form of strangulation.

The operation is, however, more difficult than for non strangulated herniae. The following points are worthy of consideration.

Identification of Sac. This is easier than in non strangulated cases as it can be recognised by the congestion and often plum coloured discolouration.

Exposure of Sac. This may be quite difficult as the overlying tissues are so inflamed that often it is not easy to know when all the fascial and fatty layers have been penetrated and the true sac laid bare.

Opening of the Sac. The sac should be stripped up to the neck before being opened, and, when opened must be dealt

with cautiously as the affected viscus may be distended closely against its wall.

When it has been opened the usual fluid will exude from the incision and, being highly infective must be sluiced away at once from the operating field.

Freeing of the Constricting Ring. The constriction ring must be sought after exploring the interior of the sac. It is possible for the constriction to be at the neck of the sac and due to thickened peritoneum. This must be ruled out before seeking other causes.

Irrespective of the site or cause of constriction it should be divided under direct vision if possible and the knife edge directed away from nearby vessels.

Before incision it is often worth while to attempt digital dilatation of the canal. This may obviate any need for incision and facilitate reduction.

Disadvantage of the Trans Femoral Approach. It is not possible with this approach to excise strangulated bowel without extending the incision up into the abdomen through the inguinal ligament.

A combination of the inguinal and femoral approaches is favoured by some surgeons. The incision is here over the inguinal canal and curving vertically down over the hernia into the thigh. The aponeurosis of the external oblique is then opened following the same curve down into the thigh through the fascia and parallel to the medial side of the femoral vein.

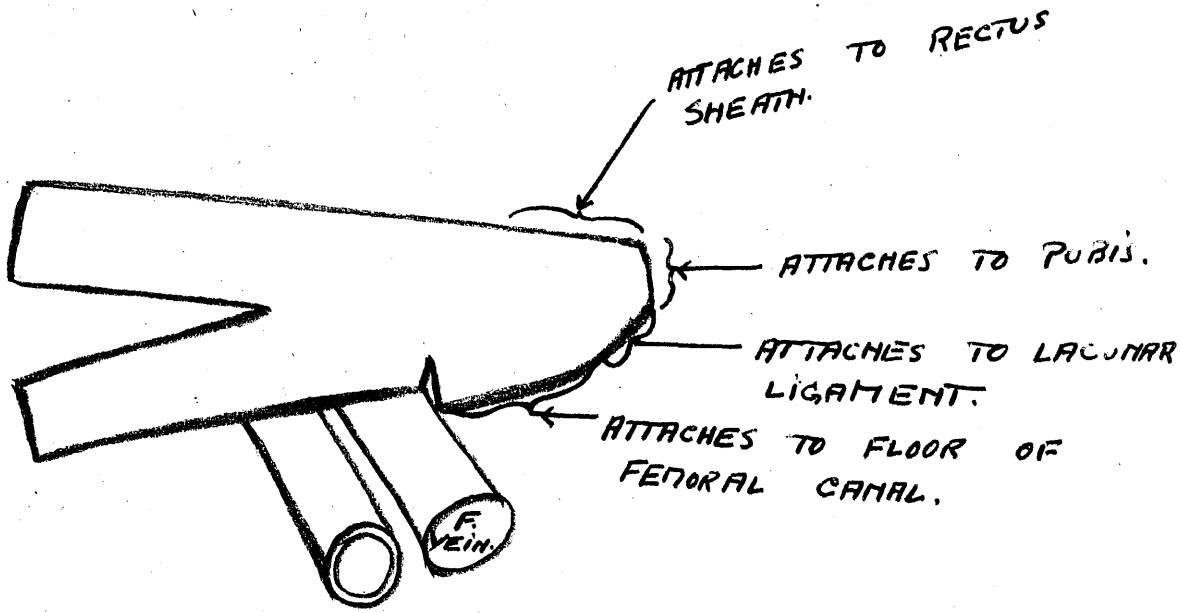

Figure 88.

Skin graft repair for femoral hernia.

CRITICISMS OF THE OPERATIONS FOR FEMORAL HERNIAE.

The fact that so many operations exist for the repair of femoral hernia is a tacit admission that the condition is not readily cured and that the anatomy of the part conspires to render repair difficult. When a repair has been performed by a trans-inguinal approach there is always a risk of later direct inguinal hernia formation through interference with the posterior wall of the inguinal canal.

The method of approach to a femoral hernia varies with the individual choice of the surgeon, but the trans-abdominal route is unsuitable for irreducible cases and the trans-femoral route is open to criticism that through it there is difficulty in ensuring complete excision of the sac at a high level, and no sure method of repair to the ring or canal can be effected. In the light of these considerations, the trans-inguinal is the best for all purposes, and is now in most general use.

To my view there are only two satisfactory methods of repair in femoral hernia.

(1) In small cases which are reducible, simple excision of the sac at a high level with no attempt to close the inguinal canal or ring.

(2) Excision of the sac after reduction of the contents and completed by the inlay of a fascial graft. The fascia

is darned between the rectus sheath and the pubis, the conjoined tendon and pectineus fascia, Gimbernat's ligament and back to conjoined tendon, and continued until the femoral ring has been occluded. It is thence carried on between the conjoined tendon and the shelfing edge of the inguinal ligament as in the repair of inguinal hernia.

I suggest that the whole skin method can be satisfactorily used for the repair of femoral hernia.

WHOLE SKIN GRAFT REPAIR FOR FEMORAL HERNIA.

FIRST STAGE. The trans-inguinal approach is used and the sac removed deep to the fascia transversalis according to the method outlined above.

SECOND STAGE. The elipse of skin removed by the first incision as for inguinal hernia is prepared in the same fashion. It is inlayed as follows.

Medially. The graft is stitched to the base of Gimbernat's ligament by one suture, to the margin of Gimbernat's ligament by a second and to the fascia over the symphysis pubis by two more. A fifth anchors it to the insertion of the rectus muscle at the pubic tubercle.

Laterally. The pedicles of skin are made to embrace the internal ring as in the method described for inguinal hernia.

Inferiorly. The first stitch is applied to the pectineous fascia and Cooper's ligament deeply, fixing the graft firmly on to the muscle and fascia. A further two stitches complete this union just medial to the femoral vein. A small nick about $\frac{1}{8}$ of an inch long is generally made in the graft at this site (see illustration), and the remainder of the inferior edge of the graft is united with the shelving margin of Poupart's ligament.

Superiorly. The upper margin is stitched in the usual way to the medial aponeurotic extension of the internal oblique muscle, and under maximum tension.

The small incision made in the lower margin of the graft is intended to avoid compression of the femoral vein and its precise position must vary with the individual requirements of each case.

When the graft has been correctly bestowed into the inguinal canal the entrance to the femoral ring and femoral canal is effectively reinforced, as is also the entire posterior wall of the inguinal canal. Danger of an inguinal hernia developing later is thus reduced.

I have not so far collected a sufficiently large number of cases to give a recurrence rate, but in the few which have been dealt with by this method the results have been immediately satisfactory, and no recurrence has so far been reported.

RECURRENCE FIGURES FOR FEMORAL HERNIA.

Reschke[46] in 1922 gave 3.5% recurrence for 170 cases of femoral hernia treated by Kummer's Method and followed up for at least one year. For other methods he gave recurrences of 28.5 and 13.8% respectively in two series of 35 and 29 cases.

Balch[47] in 1937 gave an average varying from 10-20% recurrence for cases operated on by the trans inguinal and trans femoral approaches. His cases were followed up carefully.

Of my 20 cases three recurred.

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CHAPTER 17.

UMBILICAL HERNIA.

Definition. An umbilical hernia is a protrusion of an abdominal viscus through a weak area at or in the immediate vicinity of the umbilicus.

The hernia may be found in infants, the newly born and in adults. They are conventionally classified as: 49.

1. Congenital hernia of the umbilical cord.
2. Infantile umbilical hernia, and
3. Umbilical hernia of adults.

EMBRYOLOGY.

An understanding of the development of the anterior abdominal wall and the abdominal viscera is essential to a comprehension of the etiology of most forms of umbilical herniae, and especially to that of the congenital hernia of the cord and the infantile varieties.

The umbilical cord unites the developing embryo with the placenta, and through the umbilical aperture of the foetus pass the urachus connecting with the bladder, the umbilical arteries and vein connecting the foetal and maternal circulations, some of the foetal membranes and a length of the intestinal tract.

About the beginning of the third month of intrauterine

life the intestine begins to enter the peritoneal cavity and by the middle of the third month the cavity is sufficiently large to accommodate all the abdominal viscera. The extruded intestine rapidly reaches its normal habitat in such a fashion that the caecum is the last portion to re-enter the abdomen. Subsequent development, with rotation of the gut, carries the coils of bowel to their correct anatomical situations.

During this early phase of intrauterine life there is a considerable eventration of the intestinal tract. As the foetus develops so does the anterior abdominal wall, and fusion in the midline ultimately concludes the normal growth process.

Changes in the Umbilicus at Birth. At birth the umbilical opening closes with separation of the placenta and ligation of the cord. The structure has no further function to perform. The blood within the umbilical vessels clots and the structures convert to fibrous and connective tissue. The umbilicus then contracts to form stout scar tissue supported by fibres which decussate across the midline and surround the umbilical ring, interlacing at its periphery.

Within the first week of life the stump of the umbilical cord begins to separate on a level with the abdominal wall and further contraction of fibrous tissue

takes place. These changes have the effect of closing the urachus and allantoic duct which unites with bowel. Ultimately fibrous cords come to represent the site of the various structures which related to the functioning umbilicus, and, with growth of the abdominal wall, further contraction of the umbilical scar and assumption of the upright posture, these cords become tense and firm, effecting an indrawing of the umbilicus.

Structures connecting with the Umbilicus. The umbilical vein directs down to the umbilicus from above and the two arteries upwards and medially from below. The urachus runs upwards from the bladder. Figure 89. It follows that three cords attach to the lower aspect of the umbilical cicatrix and only one from above. In consequence of this, the cicatrix becomes more indrawn in its lower aspect, and also more powerful. The fibrous cords have a buttress effect which is reputed to have an influence in preventing the development of hernia.

At birth the abdominal muscles are adequate, but not very powerful, though by the end of the first two years of life they have become sufficiently strong to prevent the development of hernia in the absence of strain.

Closure of the Anterior Abdominal Wall. Normally the mesodermal plates, from which the muscles of the anterior abdominal wall derive, close to form the umbilical ring

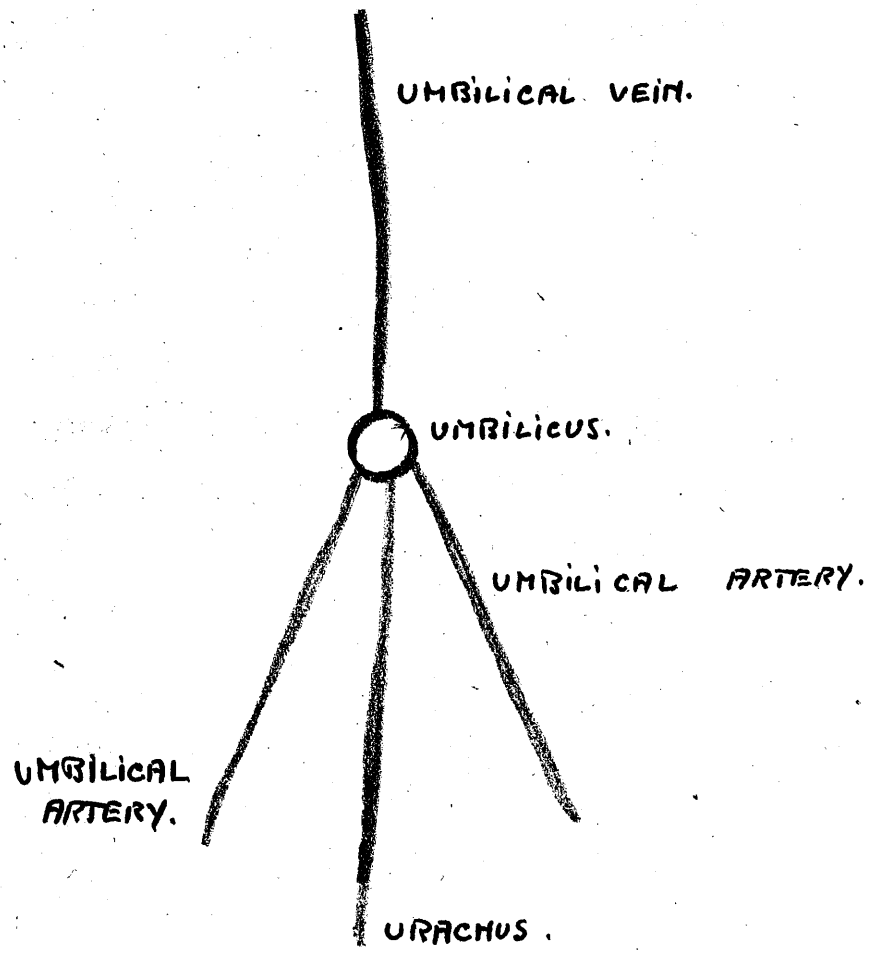

Figure 89.

Structures attaching to deep aspect of umbilicus.

during the third month of foetal life.

Closure is along the line of the future linea alba which closes first from the pubis up towards the umbilicus, and later from the ensiform cartilage downward.

This fact conspires to increase the weakness of the umbilicus in its upper half, already less strong than the lower, by virtue of the fibrous attachments in that part.

For these reasons the hernial ring is, in the majority of cases located just above the umbilicus, and, in some forms of hernia there may be an opening extending upwards towards the ensiform cartilage. The more development and fusion of this area is arrested the larger will be the future hernial ring. In extreme cases there may be failure of fusion of the abdominal wall, with a defect extending from the symphysis pubis to the ensiform cartilage.

Persistance of Extra Embryonic Coelome. Owing to the persistance of the former communication between the peritoneal cavity and the extra embryonic coelome through the umbilicus there can be a ready formed congenital peritoneal hernial sac at birth ready for the receipt of any viscus extruded into it. This is especially referable to the congenital umbilical hernia of the cord (exompholos), but the persistance of a small pouch of peritoneum into the umbilical stump may lead to the

infantile type, and it may be also that a small pouch may persist attaching to the umbilical cicatrix and predispose to hernia in the adult.

ANATOMY OF THE NORMAL UMBILICUS.

In the Child. For two years the umbilical cicatrix is relatively weak and a bulge may be prominent. With increasing growth the structure becomes indrawn by the mechanism already described.

Considerable individual variations are found from a deep conical depression to a shallow saucer which bulges readily on coughing.

In the Adult. Stout cicatricial tissue reinforces the former weak area and the structure is reinforced by interlacing of fibrous tissue over the midline and circumferentially around the ring.

In both child and adult the ligamentum teres which represents the former umbilical vein attaches to the deep surface of the umbilicus from above. Below, two cords run upwards and medially to the inferior aspect, representing the former umbilical arteries and now known as the two lateral superior ligaments of the bladder. Traces of the urachus may also be detected running up in the midline from the bladder, as a fibrous cord buried on the deep aspect of the umbilicus at its mid point.

The Umbilical Ring. The floor of the umbilicus is formed by fibrous tissue and it is surrounded by the linea alba. This powerful band of fibrous tissue extends from the pubis to the ensiform cartilage, and its anatomy has already been indicated, in Chapter 6.

For practical purposes the umbilicus may be regarded as a hiatus in the linea alba, and its surgical anatomy may be more readily understood if the anatomy of the linea alba in its immediate neighbourhood is studied.

The linea alba is a fibro aponeurotis structure placed in the midline of the abdomen, and is formed by the coalescence and interlacing of the sheaths of the recti on either side.

Neither the superficial fascia, nor the transversalis fascia or the peritoneum enter into its formation, all of these structures passing freely from one side of the abdomen to the other. At the centre of the umbilicus the skin is replaced by the scar tissue formed by healing of the umbilical stump at birth, and for the same reason the subcutaneous fat ceases at the margins of the umbilical ring so that the cicatrix is adherent directly to the superficial fascia.[1.]

In relation to the deep surface of the umbilicus is the fascia transversalis. This continuous layer of fascia lining the inner aspect of the abdominal wall varies in

strength at different areas. Deep to the umbilicus it is strengthened by interlacing transverse fibres[1.] which are given a special name, the umbilical fascia. Moschowitz stated that this is so powerful that, were it not weakened by the passage of vessels and other foetal structures, it would easily withstand any increase in intra abdominal pressure imposed upon it.

These vessels which penetrate the transversalis fascia are the foetal umbilical vessels, and one other structure, the urachus. These run up between the peritoneum and the fascia transversalis and pass through it to the placenta and cord.

There are thus four potentially weak spots in relation to the area:

1. The opening for the right umbilical artery.
2. The opening for the left umbilical artery.
3. The opening for the urachus.
4. The opening for the umbilical vein.

Finally, the umbilical fascia may be weak through maldevelopment or pathological processes thus weakening the umbilicus in its centre and predisposing to central umbilical hernia. The most frequent point of exit is that at the site of the umbilical vein, represented in the adult by the attachment of the ligamentum teres. It has already been indicated that the superior half of the umbilicus is less well buttressed than the lower.[2.]

Coverings of an Umbilical Hernia. A hernia through such an opening is covered by skin, subcutaneous fat in its upper aspect but not immediately relating to the fundus of the sac, greatly attenuated superficial fascia and greatly attenuated umbilical fascia. In practice these layers are firmly fused together and the sac is overlaid by a layer of fascia and skin separated by a variable amount of fat.

The Rectus Sheath. The rectus sheath has been fully discussed in Chapter 6, and, so far as the surgery of umbilical hernia is concerned, the point of importance is the transverse disposition of the fibres of the sheath and the vertical pull of the muscles themselves.

It is mechanically difficult and physically unsound to attempt to draw the muscles together towards the mid-line. Such an attempt is bound to fail owing to the natural line of contraction tending to separate the two structures. It is possible to close the umbilical ring, when patent, by overlapping the margins of the opening in a vertical direction, pulling the inferior portion up and deep to the upper, whilst maintaining that position by anchoring sutures. There is then no lateral pull to re-open the ring and contraction of muscles further reinforces the repair.

This is the principle adopted by Mayo in his operation for the repair of umbilical hernia.

ETIOLOGY OF UMBILICAL HERNIA.

1. Congenital Umbilical Hernia of the Cord. (Exomphalos).

The cause is a developmental error due to failure of the viscera to regress into the peritoneal cavity combined with failure of the mesodermal plates to unite and form the umbilicus.

The cause of such a developmental error is unknown, and of no practical value in the treatment of the condition.

2. Infantile Umbilical Hernia.

The infantile type is found in early months of life and usually in otherwise perfectly developed children. The relative weakness of the umbilical cicatrix in early infancy together with increased intra abdominal pressure due to any cause, and either with or without a small congenital diverticulum of peritoneum attaching to the umbilicus are the causes of the condition. In an infant the causes of increased intra abdominal pressure are numerous, but digestive upsets, early teething, phymosis and any irritation causing frequent crying are most common.

3. Adult Umbilical Hernia.

Weakening of the abdominal wall due to any cause is the most important predisposing factor. This is most often due to repeated pregnancies, and obesity. The condition is thus more frequent in women. After pregnancy

there is a temporary weakening of the abdominal muscles. If the condition is repeated too frequently and without allowing renewal of strength, the weakness may persist. Frequent pregnancies also tend to cause obesity.

Rapid emaciation in formerly healthy people is also important.

The anatomy of the anterior abdominal wall has an influence upon the etiology of umbilical hernia.

In children and in the male subject the abdomen is wider above than below the umbilicus and that structure is located in the most prominent part of the abdomen. In obesity, emaciation or muscular weakness, the umbilical area becomes more prominent and there may be a sagging of the lower anterior abdominal causing the umbilicus to lie at a lower level. In addition there is often a lateral deviation of the recti muscles under these circumstances. In obesity the separation may be considerable. If such a patient lie upon his back and be directed to rise, thus bringing into action the abdominal muscles, this lateral deviation can readily be demonstrated. Also with increased intra abdominal tension and sagging of the abdomen there is attenuation of the umbilical fascia, and the potentially weak umbilical cicatrix is subjected to strain beyond that of normal limits. Hernia development is then only a matter of time.

PROGRESS OF THE ACQUIRED HERNIA.

An adult umbilical hernia having once appeared tends to increase progressively in size and may ultimately assume dimensions which render repair extremely difficult.

A large part of the abdominal contents may ultimately be found in the sac and if the condition be chronic the abdomen will accommodate itself to this state of affairs. It may then be mechanically impossible to restore the viscera to their normal place, and adhesions within the sac will aggravate irreducibility.

The abdominal wall becomes pendulous, the umbilical ring stretched, the recti further deviated and the abdominal muscles further weakened. The coverings of the hernia are attenuated and the overlying skin may show ulcers and necrosis, partly due to trauma and partly to pressure atrophy.

No matter how large the hernia becomes it is usually possible to identify the umbilicus, which remains inverted in its lower aspect, owing to the attachments of the urachus and superior lateral ligaments of the bladder. Figure 90.

The umbilicus will frequently collect dirt or concretions, and become the seat of a dermatitis or ulcer. It is almost impossible to sterilise it before operation.

Figure 90.

Umbilical Hernia in adult immediately before operation.
Taken on the operating table.

CONTENTS OF THE SAC.

Omentum is found in all adult types, small intestine is the most frequent organ in the congenital varieties. In congenital hernia of the cord, liver or spleen are often associated with small intestine. Caecum may also be present and omentum less frequently.

In the adult massive umbilical hernia the major portion of the intestinal tract may be in the sac, part of the liver, spleen, stomach, gall bladder and, in the female even a portion of the pregnant uterus.

Omentum is constant in adult hernia and leads to early adhesion formation. These adhesions are numerous, anchoring loops of intestine to one another and to the sac in a manner which may be most complex. At operation any attempt to separate these individual adhesions by methodical ligation increases the operating time enormously and also increases the complexity of the operation.

COVERINGS OF THE SAC.

Congenital Hernia of the Cord. The coverings here are amnion and peritoneum. They are thin and translucent. The contents are thus identifiable before operation.

Infantile Hernia. The coverings are from within out, transversalis fascia, superficial fascia, the fibrous tissue of the umbilical scar, the linea alba and skin.

Adult Umbilical Hernia. In the adult there is the fused fascial layer consisting of fascia transversalis and superficial fascia, and overlaid by the umbilical cicatrix surrounded by normal skin.

INCIDENCE OF UMBILICAL HERNIA.

Congenital hernia of the cord is extremely rare, and occurs according to Watson in one birth per 10,000.

The infantile type is comparatively frequent during the first two years of life and identifiable as a protuberant umbilicus. It frequently is amenable to conservative treatment and cures with advancing years. There is no greatly increased incidence in female children. In adults on the other hand, 75% are in women during the late child bearing period.

CONGENITAL UMBILICAL HERNIA OF THE CORD (EXOMPHALOS).

Malgaine[3.] was the first to point out that this condition is not properly a hernia as the affected viscera have never entered the abdominal cavity. The condition is an eventration associated with maldevelopment of the embryo, and often coexisting with other developmental defects. Owing to the locus of the swelling and the similarity to hernia it is generally considered in association with other forms of umbilical hernia.

Classification.

The congenital form is divided into 3 varieties.

(1) A protrusion emerging through a small opening and situated at the root of the umbilical cord. This may be merely a thickening and escape the attention of a midwife. If a ligature is applied under such circumstances it may include a loop of gut or a Meckel's diverticulum and lead to a formation of a faecal fistula, or death from the results of intestinal strangulation.

(2) A sacculated hernia is the type most frequently found. It is covered by amnion and some scanty connective tissue. A sac is formed of peritoneum and may contain bowel, omentum, and not infrequently a lobe of the liver. The swelling may be as large as an orange and pedunculated owing to constriction at the umbilical ring.

This type of hernia is very fatal as its coverings rapidly become dry, and separate leaving the peritoneum exposed. In favourable cases this may undergo fibrosis but usually it becomes inflamed and leads to spreading peritonitis. Occasionally a sac may rupture.

Battle[4.] advised early operation before changes have taken place in the coverings of the sac.

(3) In the last type there is considerable deficiency in the anterior abdominal with eventration of the viscera. The child is not viable.

THE EFFECT OF EXOMPHALOS ON CHILD BIRTH.

Giffard[5] has described 3 cases occurring in the Government Maternity Hospital, Madras which presented difficulty during delivery. The 3 cases were associated with considerable deformity of the child and each presented transversely. An attempt was made to perform podalic version. The operator having introduced his hand into the uterus was "somewhat disconcerted" to find his hand working among intestine. He was unable to locate a foot owing to the size of the hernia. Each of the 3 children were dead on delivery and each had a large hernia which presented at the os.

Such extreme examples of this hernia are rare and incompatible with life. They are of little practical interest but may be encountered in obstetric practice.

A less severe type is found in one in ten thousand births approximately. It need not give rise to any difficulty during delivery but after birth care must be exercised not to traumatise the delicate coverings and to ligate the cord well away from the hernia.

COMPLICATIONS OF THE EXOMPHALOS.

The condition may be associated with other deformities and according to Cumston[6] the stomach and spleen frequently lie at a lower level than normal.

Cumston also stated that the heart and lungs may be partly drawn into the hernia where the diaphragm is low in the abdomen and associated with a large ring. This could hardly be compatible with life but all varieties of maldevelopment and malposition of the viscera may be found.

The mesentery may be longer than usual. This may be due to traction upon it by the herniated bowel. It is probable that the increase in the length of the mesentery is secondary to the hernia and not a predisposing cause.

The allantoic duct may be patent and intestinal contents discharged at the umbilicus. If the duct is partly closed the Meckel's diverticulum may be within the sac. An example has been described by Battle.[4 and 9.]

If the urachus remains patent, urine may be discharged at the umbilicus. This is rare in association with congenital umbilical hernia. Ballantyne[7.] and Gallant[8.] have described in detailed papers the various other forms of umbilical fistulae and classified them as (1) faecel, (2) gastric, (3) biliary, (4) haemorrhagic and (5) urinary.

The hernia is subject to the same complications common to other types. It is often reducible at birth but not infrequently may be irreducible due to either the bulk of the contents together with a narrow umbilical ring or due to the intersaccular adhesions. If irreducible,

operation is more urgently indicated, and strangulation is possible. Strangulation may be present almost immediately after birth and is associated with a high death rate.

Damage to the Coverings.

The coverings may be damaged at birth during delivery by attempted internal version and by careless handling after birth. In that event inflammation of the coverings leading to peritonitis is probable. As the amnion dries the vitality of the coverings becomes reduced and mild trauma may precipitate disaster.

Rupture of the Coverings. The sac and coverings may rupture spontaneously as a result of severe straining or crying. Infection of the area is probable with the usual fatal sequel.

Changes within the Sac. A prominent feature at operation is the number of adhesions which have to be dealt with. This has been remarked by Palmer.[10] These adhesions may be due to a persistance of the vitalline duct. These adhesions may have a part in the etiology of the condition in that they may prevent the coils of the primitive gut which lie in the third month in the extraembryonic coelome from retracting into the abdomen and thus prevent closure of the abdominal walls.

SIGNS AND SYMPTOMS.

The third type of congenital umbilical hernia need not be considered at this stage as it is associated with gross mal-development and is incompatible with life. Type 1 may be noted only as a thickening at the abdominal attachment of the cord. The sac may contain no viscus and if it can be kept empty may lead to no trouble by the time the stump of the cord has separated. Occasionally after separation of the cord the sac may not have become obliterated and the umbilical cicatrix be associated with a delicate peritoneal protrusion which is liable to trauma and inflammation. It often closely resembles a mild degree of the second type.

In the second type there is a definite hernia at birth varying in size up to an orange. The coverings are translucent and the contents visible through them. The colour is bluish red but if there is obstruction or irreducibility they may be more congested. The surface of the swelling is smooth and even and its consistance depends upon the affected viscera. It may be firm and resilient if liver and spleen are involved or characteristically reducible with a gurgle when bowel or stomach are present.

The presence of intrasaccular adhesions may render reduction difficult and any attempt at forced taxis may

traumatise either the coverings and sac on the one hand or the viscera within, or the other.

Treatment of Congenital Umbilical hernia of the Cord.

Treatment is indicated usually in only the second variety, where the child is viable and a sacculated hernia present.

The treatment may be mechanical or operative. Mechanical treatment by a firm pad and binder is applicable only to small cases and even then is usually inferior to radical cure.

If the hernia is small and the child's condition poor conservative treatment is indicated. If the general condition is satisfactory, operation is preferable.

Radical Operation. The earlier this is performed the better the prognosis. A successful result has been gained by operation one-half hour after birth. Alder[11.] collected 72 cases from the literature and found that when operation was undertaken in the first twenty-four hours of life the mortality was 12 per cent.

Extraperitoneal Approach. The extraperitoneal approach is generally used because it produced less shock and has a lower mortality. The amnion and Wharton's jelly are separated from the underlying cavity. The margins of the hernial ring are rawed on both sides, the sac folded and sewn into position over the ring and the muscles and

skin edges brought together over it with strong sutures. Any tendency for the wound edges to separate is lessened by applying firm adhesive straps around the body.

Intraperitoneal Approach. The intraperitoneal operation is used when it becomes necessary to open the abdomen to examine the viscera or to deal with peritonitis.

The following method is satisfactory:[12] Make a small vertical incision one inch long at the lower part of the hernia, and with a gauze pad in the wound to hold back the viscera, freshen the edges of the muscles and fascia and draw them together by a through-and-through suture of silk-worm gut. The first incision should be prolonged one-half inch and a second suture introduced. In this way the operation proceeds until the upper margin of the hernial opening is reached, when the sac is excised, the peritoneum closed with a running stitch, and the sutures tied.

ESSENTIAL STEPS OF OPERATIONS.

In either the extraperitoneal or intraperitoneal operations certain essential steps must be performed if the repair is to be successful.

Opening of the Sac. The sac must be carefully exposed and opened in order to inspect the contents before reducing them back to the abdominal cavity. This is obligatory at

operation owing to the frequency of intrasaccular adhesions and the necessity of freeing them before being able with safety to attempt reduction.

These adhesions may so loculate the sac that the sac would appear to open into the abdomen through several mouths.[48.]

In addition there is frequently constriction of the bowel at the neck of the sac. This may be sufficiently strong to lead to early strangulation and, if the bowel has been damaged peritonitis may follow too hasty reduction.

Reduction of the Contents. The umbilical ring may be very small and reduction difficult. It is then safer to enlarge the ring by a vertical incision upwards in the mid line than to jeopardise the integrity of the bowel by forcible attempts at reduction by taxis.

In cases where adhesions are numerous and access to them difficult, a clearer exposure may be gained by enlarging the ring. Separation of the adhesions is the essential prelude to reduction. The adhesions may be relatively vascular and should be individually identified and cut between fine ligatures.

Disposal of the Sac. The sac may be excised or folded upon itself and used to buttress the deep aspect of the future umbilicus. In either event the margins of the ring

are made to overlie the sac and close the ring.

The skin is closed by a few interrupted sutures.

COMPLICATIONS OF OPERATIONS. Occasionally other abnormalities of the umbilicus may be found, for example persistance of the vitelline duct, or patency of the urachus. These must be dealt with according to their extent, but do not otherwise modify the fundamental steps of the treatment of the hernia.

Ballantyne[7.] has given a full account of them in his monograph.

Battle considers that where there is a patent vitelline duct it should be excised flush with the bowel wall.[4.]

Difficulty may be experienced owing to the round ligament of the liver preventing reduction of the sac contents. This may also anchor a lobe of the liver when that viscus is related to the hernia and prevent its reduction. This is readily dealt with by cutting the ligament between two stout ligatures.

Haemorrhage from the umbilical vessels may be profuse. These should be ligated at the margins of the ring before any attempt is made to raw its edges. They are best deliberately identified and ligated in the early stages of the operation.[20.]

PROGNOSIS.

The prognosis is grave unless the hernia is reduced and the opening closed by operation. The operation should be performed whilst the sac is still moist, before the hernia has been enlarged by the intake of food and as soon as possible after diagnosis has been made.

MacDonald[13.] recorded nineteen cases which were operated upon with two deaths. He also collected twelve other cases treated by pad and binder with nine deaths.

In 1900, Hansson[14.] reported a series of 62 cases dealt with surgically. There were seventeen deaths. Yates and Davies[15.] give a death rate of 32% for 71 cases treated by operation.

2. INFANTILE UMBILICAL HERNIA.

This variety is often overlooked at birth and noticed only as a small eversion of the umbilicus present when the child cries.

This eversion may enlarge unless controlled, and ultimately become spherical. In the early stages it is symptomless but later is capable of causing attacks of colic relieved by reduction of the swelling.

Contents of the Sac. The most common viscus found within the sac is intestine, and that only when the child cries.

Omentum is rarely present. The sac is generally empty at first and in the absence of straining. Owing to the infrequency of omentum adhesions are not common and strangulation rare.

Symptoms and Signs. These have largely been indicated above. There is a swelling in relation to the umbilicus, appearing within a few weeks or days of birth and at first only present when the child strains, usually by crying. Later it may be more than an eversion of the umbilicus, spherical in shape and present apart from straining. The condition is usually reducible, and associated with colic relieved by reduction. The colic may cause periodic attacks of crying when the child lies in an attitude of flexion. This crying may cease when the swelling has been reduced.

Complications of incarceration, irreducibility and strangulation are rare. The general condition of the child is usually otherwise good and there need not be any other congenital abnormality.

Treatment. There is a wide impression that this condition tends to spontaneous cure provided the swelling is kept reduced by a firm pad and binder. Grey Turner[16.] suggests that this cure is often imperfect, and that a sac persists ready to cause adult umbilical hernia in later years. He

maintains that the condition should be viewed not from that of its "comparative harmlessness, but from that of its potentialities".

Mechanical Treatment. This consists of applying a firm pad to the umbilicus and maintaining it in position by a binder. A coin wrapped in soft material has been recommended as a pad. The operative phrase is "maintaining it in position". This is not an easy thing to do in a young child, the contortions of whose lithe young frame are well calculated to displace any pad and binder within a short time.

Success may become nearer by removing all causes of irritability met with. Irritative rashes due to wet nappies should be avoided by frequent and regular cleansing. Nursing should be efficient, and calculated to keep the child fit and in good humour.

The pad should be at least four square inches in size, if square, and at least two inches in diameter if round. It should consist of firmly rolled up gamgee or wool, or a disc of metal or cardboard protected by wool and a bandage. This should be placed over the umbilicus when the hernia has been reduced, and maintained in position by a firm binder. The binder should be pinned at intervals of one and a half to two inches down its margin to avoid uneven stretching, and can be kept from sliding upwards or downwards by carefully designed braces

over the shoulders, and between the legs. These last should go over the nappies. Chafing of the thighs and perinaeum may thus be minimised.

Care must be taken to cleanse and dust the umbilicus and skin around it twice per day. The skin must not be permitted to be irritated by the pad.

Mechanical treatment must be persisted with for many months, if not for the first two or three years of life. From every point of view it is a difficult procedure. It must be arduous to the child and certainly is to its attendants. Operation is more satisfactory.

Operation. This should be performed in all cases over a year old, as mechanical treatment is then unlikely to be useful. The main essentials of the operation are:

1. Fashioning of an incision to preserve the umbilical cicatrix.
2. Excision of the sac.
3. Closure of the ring.

Preservation of the Umbilicus. Roeder[17] has described a good operation for the preservation of this structure. His operation is not suitable for adult umbilical herniae where the abdomen is obese.

Any incision should be curved, either with the convexity upwards or downwards, and the flap raised from the underlying sac to which it is usually adherent. The

ingenuity of the individual surgeon can be called into use to fashion the incision according to the best requirements of the individual case.

Excision of the Sac. The sac is exposed and cleared right to its neck. It is then opened, any contents reduced, and cut off at its neck. The opening in the peritoneum should be closed by a few interrupted sutures.

No special difficulty is encountered during this stage of the operation.

Closure of the Ring. The abdominal wall may be closed by transverse or vertical suture of the ring. The first method is the more mechanically sound and that adopted by Kocher and Mayo. The vertical method may occasionally be used in small openings.

The technique of the transverse Mayo method is described in relation to the adult operation in the next section.

There is no indication for any elaborate method of closure in these infantile cases. Fascia or skin are not indicated and recurrence is improbable.

The operation is concluded by closing the skin incision by a few interrupted sutures.

There is one method particularly suitable for the repair of reducible infantile umbilical hernia. It has the advantage of preserving the umbilicus, avoiding a large

incision, and is less shocking to a weakly child than a femoral herniotomy. The method is subcutaneous ligature of the sac.

Subcutaneous Ligature of the Sac. The elastic ligature has been recommended by Brun[18] and Fraser.[19] Other types of ligature have also been used, and I have performed the operation in eight cases of infantile umbilical hernia with complete success using number one cat gut.

Indications. The operation should not be performed below the age of six months,[19] and the optimum age is one year. During this preoperative period support should be given by a pad and binder. The sac must be empty. Any irreducibility is an absolute contraindication.

Technique. The skin over the fundus of the sac is grasped in dissecting or Allis tissue forceps and gently pulled upwards from the abdominal wall. Three small incisions, each about one eighth of an inch long, are made at equal intervals round the periphery of the sac at the point where the skin reflects on to the abdominal wall. These incisions penetrate only the skin and subcutaneous tissues.

A curved blunt dissector is used to undermine the tissues round the pedicle of the sac.

The chosen ligature is then threaded round the neck of the sac, and introduced, either by an aneurysm needle or blunt curved director, through the small puncture wounds.

The ligature follows the track of separation. Curved artery forceps are useful for the purpose. When the ligature is in position care is again taken to ensure that the sac is empty. The sac is then pulled taut away from the anterior abdominal wall, and the ligature tied off and drawn tight. If the ligature is absorbable the ends can be cut off deep to the skin. Otherwise the ends are left protruding from one of the incisions and cut to a convenient length.

A small collodion or dry dressing is applied and kept in position by adhesive plaster.

After Treatment. The ligature, if unabsorbable is removed at the end of a week by cutting the knot and pulling out.

There is no other point in the after treatment.

Results. The results of treatment by this method are excellent.

3. ADULT UMBILICAL HERNIA.

Classification. These herniae protrude through the anterior abdominal wall in relation to the umbilicus. There are several points through which they may theoretically pass. These have been indicated in the section on anatomy. Generally they emerge through the opening for the umbilical vein in the upper margin of the umbilical ring. In practice however they are not classified

according to their point of emergence, but according to their condition, reducible, irreducible, obstructed and strangulated.

Signs and Symptoms. The condition generally appears during the fourth decade of life and is progressive, increasing in size to dimensions which may be grotesque. It is found in all types of subjects, but is most common in women who have borne several children.

Obesity. This fat is due often to repeated pregnancies, and is important, in that it may be so marked as to mask any swelling buried in its substance.

On examination of a suspected umbilical hernia there must be a careful examination of the anterior abdominal wall with the patient erect and also prone. Deep palpation may detect a somewhat tense swelling deep in the fat and relating to the umbilical area, which is painful on palpation.

Gastro intestinal Symptoms. Many patients experience pronounced gastro intestinal disturbances due to adhesion of omentum within the sac. This may cause traction upon the colon, the stomach or small intestine. Traction on the colon may produce hypogastric pain, nausea, vomiting and constipation.

Pendulous Abdomen. The patient when examined erect is often found to have a pendulous belly and a large fold of

fat depending over the pubis. When lying prone and instructed to raise the head and shoulders from the bed, it can usually be observed that there is a degree of divarication of the abdominal recti, and that the abdominal muscles are lacking in tone. These circumstances prejudice the success of repair and favour increase in size of the hernia.

Pain. There is often a dull steady dragging pain due simply to the weight of the swelling. In small cases there may be little pain so long as the condition is reducible. Obstruction or irreducibility brings pain referred to the appropriate viscus, and located in the back/ hypogastrium or umbilical area.

Frequently the patient experiences attacks of colic, often attributed to "wind". These are due to a transient obstruction short of actual strangulation.

Skin Irritation. There are three chief areas of skin irritation. The first within the umbilicus itself and due to collection of dirt and concretions. The second in the fold of the pendulous belly, and due partly to contained sweat plus mechanical irritation of apposed skin surfaces. The second is due to atrophy of, and trauma to, the overlying skin. This varies considerably in degree and is most common in persons who have worn a truss.

The overlying skin is often thin and unhealthy,

ill-equipped to withstand irritation or trauma.

Cardio vascular Complications. These patients being obese and flabby often suffer from myocardial insufficiency. This is frequently associated with chronic bronchitis, elevation of the blood pressure, and possibly also albuminuria.

The general condition is rarely good. This indicates a need for careful preoperative treatment, the wisdom of operating before strangulation has developed, and also the need for a swift operation minimising the duration of anaesthesia.

COMPLICATIONS.

The complications are those common to all hernia, and modified only by the site of this variety. Strangulation is more common than with many other types of hernia and hence is a cogent reason for not delaying in operating upon cases which are in good general condition.

The majority of umbilical herniae are irreducible and associated with pain, discomfort and occasional periods of partial obstruction. Thus, when strangulation does occur, it is frequently not noticed until the patient realises that the symptoms are due to something more grave than she has previously experienced. For this reason

strangulated cases are often not sent to hospital until the general condition has deteriorated. The causes, signs, symptoms and progress, of these complications varies not at all from what has already been described in earlier chapters.

The mechanical treatment of umbilical hernia dates back to the earliest days of recorded history, and was described by Celsus in the 1st century A.D. A pad and bandage was used in much the same fashion as to-day.[22.] Celsus observed that the mechanical treatment was suitable for children. It must be emphasized that while it is still suitable for selected cases in children to-day, it is entirely unsuitable for the average adult umbilical hernia. In 1881 Lucas-Championniere[23.] advocated overlapping of layers of fascia to close the ring and Mayo[24. 25.] in 1894 evolved his operation. Since that day there have been several modifications of the Mayo repair, but it has become the standard surgical treatment of adult umbilical hernia and of most cases of the infantile type also.

TREATMENT.

The standard operation for the repair of adult umbilical hernia was evolved by William Mayo[21.] and described in 1895.

Mayo considered that umbilical hernia was caused by

downward traction of the abdominal walls so that their contents were brought to bear on a fixed point at the umbilicus, thus causing separation. This process was associated with an increase in the vertical length and also, to a lesser extent in the lateral width of the abdominal wall. He accordingly commended vertical overlapping of the margins of the umbilical ring in preference to transverse overlapping or transverse apposition of the edges. The first repair was performed in 1895 and in 1909 he was able to write "to-day the expectation of cure in this case equals that of inguinal hernia".

Mayo's Operation. The essential steps of the operation may be summarised as follows:

1. Transverse elliptical incisions are made surrounding the umbilicus and the hernia. These incisions are deepened through skin and fat to expose the anterior aspects of the sheaths of the abdominal recti, the linea alba and the aponeuroses of the external oblique.

2. The fat is stripped from the surface of these aponeurotic structures up to the neck of the sac, thus mobilising a wedge shaped elipse of tissue consisting of skin, fat and embedded within it, the hernia. This clearance is important and must be carried out right to the neck of the sac.

3. The coverings of the hernia and its sac are divided in a circular manner at the neck, thus exposing its contents. This incision must be made with regard to the fact that the contents of bowel and omentum are usually found forced against the wall of the sac at the neck, are irreducible and may be inadvertently injured during the process.

4. Any adhesions which are present in the sac are separated and bowel or other viscus restored to the abdominal cavity. Any omentum which is present is removed with the sac of the hernia by ligation and excision at the neck, thus avoiding tedious dissection of the adherent portions of omentum.

5. An incision is then made through the aponeurotic and peritoneal structures of the ring extending for up to an inch transversely on either side. The peritoneum is separated from the under surface of the superior of the two flaps thus formed. Approximately two to two and a half inches above the margin of the upper flap three or four mattress sutures of silk or other stout material are introduced in such a fashion that the loop of the mattress formed grasps the upper margin of the lower flap.

The opening in the peritoneum is closed with a running stitch of fine cat gut. Hadtler[47.] has advised the use of several purse string sutures inserted around the

parietal peritoneum immediately proximal to the stump of the sac in order to take up any slack and reinforce the area by a thickened pad of peritoneum. The mattress sutures are then drawn tight sliding the lower flap behind the upper and into the pocket which has already been formed between the upper flap and its adjacent peritoneum. Figure 91.

6. The free margin of the upper flap is now sutured to the surface of the aponeurosis below and the superficial incision closed in the usual manner.

Technical Difficulties during the Operation. These umbilical hernias may frequently be associated with so much fat as to render it necessary to make a very large elliptical incision in order to gain satisfactory exposure of the operation area. There need be no fear in making a generous incision, as shock to the patient is not thereby increased and a much more efficient closure of the ring will be achieved. Haemorrhage is rarely difficult to control save occasionally when stripping the fat from the aponeurosis of the anterior abdominal wall, when smaller vessels emerging through the anterior sheaths of the rectus muscles may be cut.

The neck of the sac is frequently very narrow and the umbilical ring may admit only two or three fingers, yet the sac itself may be very large. The structure can

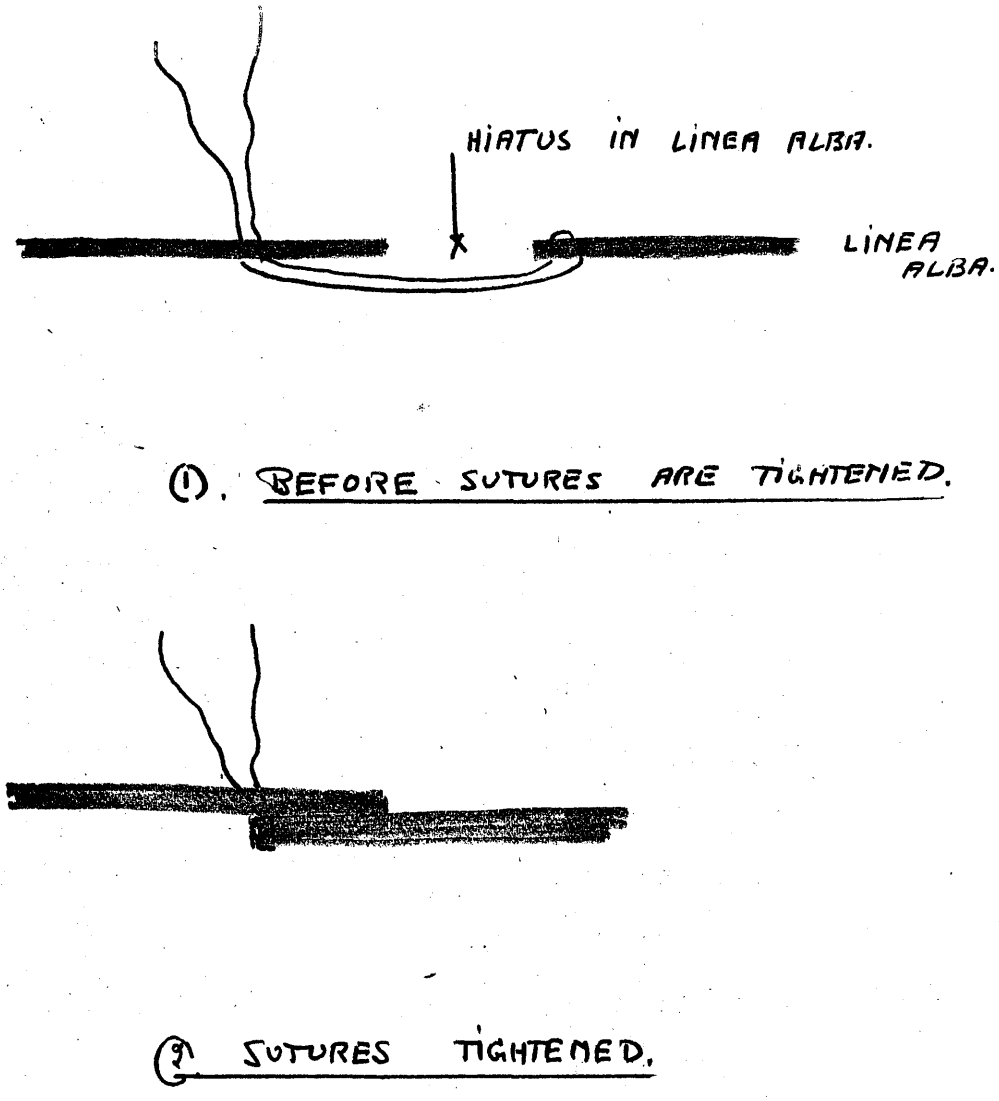

Figure 91.

Diagrammatic representation of the overlap principle in the Mayo Repair.

be likened to a large toadstool with a slender stem. Through this narrow neck may pass a substantial part of the intestinal tract and adhesion to the sac wall is close. Great care must be exercised in making the circular incision round the neck when opening the sac. When it has been completely detached from the abdominal parietal peritoneum the hernia with its surrounding loops of skin and fat remains attached by the viscus entering the sac. The sac should then be opened in the line of this viscus from the neck. Omentum is ligated at the neck and adhesions between bowel and omentum separated. It is unwise to conserve the omentum which is usually fibrous and densely adherent. There is also less mechanical embarrassment to the patient if it is excised, as the abdominal cavity has become accustomed to a portion of its contents being housed elsewhere.

The margins of the umbilical ring are usually rounded and fibrotic. They should be freshened and mobilised carefully after making the lateral incisions and all fat should be removed with especial care from the anterior surface of what is going to be the lower flap. If this is not done when the flaps have been made to overlap, areolar and fatty tissue will insulate the adjacent surfaces and prevent union between them, thereby causing an increased risk of recurrence.

If the contents of the sac are especially large and the hernia is chronic much difficulty may be experienced in returning them to the abdomen unless the umbilical ring has been generously enlarged. Occasionally it may not be possible to return them at all and resection of bowel becomes necessary. This is considered under the heading of "Massive Hernias" later in this chapter.

Finally, when the mattress stitches are being tied and the lower flap being drawn up and behind the upper, care must be taken to see that a knuckle of bowel or a tag of omentum is not caught up in the stitch thereby causing later pain or recurrence.

Results of the Mayo Operation. In 1907 William Mayo considered the results of his operation on the basis of 13 years' experience. During that period he operated on 126 umbilical hernias by his method and traced 75 of them. One he stated, had a "partial relapse" which did not occasion her any inconvenience. A second patient had a definite relapse but Mayo stated that at operation the original umbilical ring was found firmly closed. The second hernia had emerged through another ring lateral to the first. I do not understand what Mayo means by the description "partial relapse". It seems to me that a hernia either relapses after operation or it doesn't. In any case he had only two recurrences out of 75 traced

cases. This figure is remarkably good, and so far as I know, has not been equalled by anyone before or since. In the experience of most other people, the results of the Mayo operation whilst better than those for any other method of repair tend to be unsatisfactory and to be associated with a substantial recurrence rate. No explanation for this seems to be forthcoming upon examination of the literature and it would not be correct to say that Mayo was more skilled in surgery than anyone who has succeeded him. My own feeling is that his cases were not followed up by personal re-examination. In his paper he simply stated that the cases were traced.[27.] Pringle,[28.] Du Bose and Kelly[45.] are amongst those who have found the Mayo repair unsatisfactory and have evolved methods of their own to improve upon the original principal evolved by Mayo. Others have used fascia to stitch the flaps together but recurrences were still frequent.

A Criticism of the Mayo Repair. In my view the Mayo operation may be criticised upon the following grounds:

1. When the overlap has been made and the flaps sutured into position a species of tuck has been made in the anterior abdominal wall. This tuck has at each lateral extremity the end of a tunnel along which a probe or artery forceps may be passed. It is possible for a smaller wedge of peritoneum to insinuate itself between

the deep mattress sutures and follow this tunnel along to make a new hernia. It is difficult if not impossible, to avoid making this tunnel and although diagrams may be drawn very beautifully to show how efficiently the overlap repair closes the umbilical ring they are misleading, as, in practice, this tunnel usually is found.

2. The muscles and linea alba are frequently weak. Muscles infiltrated with fat are unlikely to give effective support to the abdominal viscera when the patient once more rises from bed.

3. The results of operation in the hands of most people give a high recurrence rate varying up to 30 per cent. This fact in itself shows that the operation leaves much to be desired. In a series of 30 cases studied by Simmons[29.] there was a 10 per cent. recurrence and in 45 cases 22 per cent. recurrence.

Suggested Improvement upon the Mayo Repair. In order to achieve a firm union and reinforce the anterior abdominal wall a plastic repair with fascia or skin may be used in order to inlay at least one more layer of stout fibrous tissue over the weak part of the abdomen. A circular patch of skin measuring 2 to 3 inches in diameter, unstretched, can be stitched under tension to the aponeurotic structures of the area and centred over the former umbilicus after a classical Mayo repair has been performed.

Stitches should be inserted, separated by one third of an inch, at points around the circumference of the graft. These obliterate the end of the tunnel previously mentioned and the graft adds one more layer of stout tissue to the anterior abdominal wall.

A similar method may be adopted using a plaque of fascia or fascial strips may be interlaced over the area of extending wall lateral to it.

TECHNIQUE OF THE SKIN GRAFT REPAIR FOR UMBILICAL HERNIA.

Pre-Operative Treatment. The skin of the abdomen is shaved and prepared with ether soap and spirit compresses for three days before operation, as in the skin graft technique for inguinal hernioplasty. The bandages are not removed on the third day until the patient is on the operating table.

The usual premedication of $\frac{3}{4}$ to 1 c.c. of omnopon and scopolamine is administered one hour before operation. Operative technique. 1st stage. A classical Mayo repair is performed along the lines laid down earlier in this chapter. The skin from which the graft for repair is taken is that removed by the elliptical Mayo incision which is always ample for the purpose. Figure 92.

Figure 92.

The skin incision enclosing a substantial ellipse of skin, fat and the hernial sac has been made and the tissue mobilised to show the skin from where the graft is taken, and also the neck of the sac deeply in relation to the hiatus in the linea alba.

When the ellipse of tissue comprising skin, fat and hernial sac, with any excised omentum has been removed from the abdominal wall, a portion of skin measuring 3 to 4 inches wide and 2 to 3 inches deep, is excised for future use. This is placed in normal saline solution at blood heat until required.

It is essential after having concluded the overlapping step of the Mayo repair to clear the linea alba and the anterior rectus sheaths of all areolar tissue for a distance of approximately two inches above and below the site of the former umbilical ring. Figure 93. It is also desirable to clear the medial portions of the internal oblique aponeuroses for an inch or so lateral to the rectus muscles. When this has been done a clear area of aponeurotic structures will have been exposed and prepared to receive the skin graft.

Second stage. Preparation of the skin graft. The portion of skin which has been removed and placed in saline is now taken and shaped to form an elipse measuring 3 to 4 inches by 2 to 3. All fat and areolar tissue is then carefully removed from its deep aspect. The graft is then ready for use.

Third stage. The inlay of the graft. The extremities of the graft are steadied by 4 pairs of Allis' tissue forceps and lifted on to the prepared area of the abdomen. The

Figure 93.

The Mayo repair has been completed. The sutures are not well shown in this monochrome photograph. The bed is ready for inlay of the graft.

graft is then disposed in such a fashion that it is centred over the former umbilical ring and overlies the closure of that ring made by the Mayo technique during the first stage of the operation. It is then anchored in position and under maximum tension by interrupted stitches inserted around its periphery. The first 4 stitches are placed at 9, 3, 12 and 6 o'clock and care is taken to stitch the graft first in its transverse diameter to its maximum extent, and, secondly, in its vertical diameter to its maximum extent. The remainder of the stitches are inserted to maintain this principle and when they have been correctly placed the graft will be glistening and tense, resembling the pig-skin of a drum and sutured only to fibrous tissue. Figure 94.

When all haemorrhage and oozing has been controlled, a film of sulphonamide powder is insufflated over the operation area and the skin edges approximated by interrupted sutures of linen or silk gut. It may be considered advisable in obese subjects to suture the fatty layers together by a continuous fine catgut. This prevents or minimises the formation of a space between the surface of the graft and the overlying skin. In thin subjects it is not necessary.

Figure 94.

The skin graft has been sutured into position overlying the Mayo repair.

CRITICISM OF THE SKIN GRAFT OPERATION FOR UMBILICAL HERNIA.

Duration of Operation. The use of the skin graft technique increases the length of the operation by approximately 15 minutes in my experience. If the patient is a good surgical risk and the first stage has not taken long, this increase in the operating time is of no significance. If, however, the patient is a chronic bronchitic, has a poor myocardium and is a poor subject for operation, the expenditure of this extra time, may not be considered justifiable.

It has been suggested that operations may be considered under the headings, major and minor, the major being those which last longer than one hour. It should almost always be possible to perform a whole skin graft repair for umbilical hernia in under an hour, and in my experience with the operation there have been no untoward results through the expenditure of the extra 15 minutes. My cases have been without exception obese subjects suffering from chronic bronchitis as a rule, and in several the myocardium was not healthy. Despite these handicaps the patients weathered the operation well.

Sepsis. The portion of skin which is used for the repair of umbilical hernias in adults is several times larger in surface area than that used for inguinal repairs by the

same method. Moreover, the subjects are usually obese and the skin itself may be atrophic and of poor quality. These facts would apparently favour sepsis. In my small series of 18 adult umbilical hernias the skin graft repair was performed in 15. Three of these were complicated by sepsis and in 2 cases the sepsis persisted for approximately 3 weeks. I was unable to satisfy myself that the complication was due to the inlay of skin, because the patients both weighed 19 stones and in addition to the repair of the umbilical hernia a lipectomy was performed. The incision was H shaped and the sepsis in both cases appeared at the junction of one of the vertical limbs with the transverse. The late results in both cases were satisfactory. In the third patient a small haematoma formed in the midline of the wound, and discharged on the seventh day. The discharge was apparently uncontaminated, but 2 days later it was somewhat purulent and a pussy discharge continued for some 10 days. The patient was a man who suffered from chronic bronchitis and chronic alcoholism. His hernia recurred after some eight months when he was engaged at his work in a brewery and lifting barrels on to a lorry. He returned to hospital for a skin operation and died on the 15th post-operative day of a typical coronary thrombosis. At the second operation in this patient the skin graft was found to be firmly attached to all structures

save the linea alba below the umbilical ring. The new hernia had pushed its way deep to the graft and emerged subcutaneously in relation to its inferior edge.

THEORETICAL ADVANTAGES OF THE SKIN GRAFT OPERATION.

The graft forms a stout plaque of fibrous tissue over the central weak area of the abdomen. It also unites the recti muscles on either side across the midline and should minimise or reduce any tendency to diverication.

According to Mayo himself, in most cases of umbilical hernia, owing to increase in the vertical and transverse diameters of the abdominal wall, the weight of the abdominal contents is referred to the umbilicus and tends to either cause or aggravate any hernia which is present. When the skin is used to reinforce a primary Mayo repair this weak area of the abdomen is strengthened by the formation of one more layer of tissue across it. It acts in fact, as an extra layer to the anterior rectus sheaths and the linea abla.

Nine of my 18 cases were followed up for one year or more. One recurrence was found after the skin graft repair, this has already been mentioned, one recurrence was found after the ordinary Mayo repair without the additional skin graft. This last was in a very stout young woman of 24, who weighed 17 stones. The hernia

recurred 3 months after operation. Of the 9 cases which were followed up, 8 were skin graft repairs the remaining one was the recurrence mentioned.

UMBILICAL HERNIA AND LIPECTOMY.

Fat has amongst its uses the preservation of structure and the aiding of beauty by rounding out or helping the symmetry of the body, but when it becomes excessive it is a nuisance and burden to its owner.

Umbilical hernia is frequently associated with an excess of abdominal fat. This may be so gross as to lead to a pendulous belly, and, by the formation of fatty folds cause dermatitis or chafing of the skin.

It is practicable and also beneficial to the patient to remove some of this surplus fat during operation for umbilical or ventral hernia. A wedge shaped slab of fat is removed at the operation. The size is calculated according to the needs of each individual, but should be sufficient to permit stitching of the skin edges without tension, and yet eliminate any redundant fat causing pendulous abdomen. In my 18 adult cases lipectomy was performed in 15 and the average amount of fat removed in each case, was 5 pounds. In a series of 103 cases of umbilical hernia quoted by Lathrop[30], 46 had a former lipectomy. Amongst these there were no deaths.

Incision for Lipectomy. There are two types of incision. The ordinary Mayo transverse can be used to remove a wedge of fat up to 5 or 6 pounds in weight. This is suitable for all but the most massive abdomens.

It has been criticised on the grounds that when lipectomy has been performed and the wound closed, there is no reduction in the transverse width of the abdomen and that the lateral extremities of the wound tend to pucker. This is a somewhat superficial criticism because the unfortunate subjects who require the operation are not likely to be converted into slender figures, and they are usually grateful for what has been done.

In the second the skin incision is H shaped. Each limb of the H is fashioned as an ellipse, so that a lateral wedge is removed on either side of the abdomen to narrow it transversely. This incision has one disadvantage, there may be delayed healing where the transverse incision joins the vertical. Tendency to sepsis is aggravated by the impaired vitality of the tissues found in a stout abdominal wall.

Pendulous Abdomen and mechanical support. A woman with a pendulous abdomen frequently wears a so-called stomach lifting or form fitting corset in an effort to mask the underlying truth. These corsets are rarely satisfactory and only so when made carefully to the measurement of each

individual case, and fitted carefully to her requirements. They rapidly stretch and become ill-fitting. It is wise to possess several which should be worn in rotation.

The corset has one danger. Increased pressure due to it may aggravate the tendency to complications. Further, because it is often regarded by the patient as a truss, which it is not, it may give a false sense of security. If the hernia is incarcerated, the corset should not be worn.

PRE-OPERATIVE TREATMENT IN MASSIVE UMBILICAL HERNIAS.

McGlannon[31] distinguished as massive, those hernias having a ring or not less than 40 c.m. in circumference, or a capacity of 500 c.c.m. and also smaller hernias occurring in obese individuals where the pendulous abdominal walls require the removal of an area of skin and fat not less than 10 c.m.s. in the short diameter. In my view massive hernias are also those occurring in subjects weighing 15 stones or more, irrespective of the size of the hernia. These cases present special complications from both the local and general point of view. The patients frequently suffer from chronic bronchitis, myocardial degeneration, albuminuria, or elevation, in the blood pressure, and if subjected to operation are liable to certain post operative complications. These may be classified as follows:

1. Those arising from the cardio-vascular-venal systems: dilatation of the heart, pulmonary oedema, pulmonary embolism or cerebral haemorrhage.

2. Those arising from the intestinal tract and peritoneum: paralytic ileus, acute dilatation of the stomach or peritonitis, and

3. Those arising as a result of complications of the hernia: peritonitis, toxaemia and embolism of the mesenteric arteries.

In cases of true massive herniae there is one complication peculiar to the condition. In a chronic case a large portion of the abdominal viscera may long have been contained within the hernial sac. Any attempt to return the viscera to the abdomen which has adopted itself to their absence, requires a readjustment of the circulatory balance and intra-abdominal-thoracic pressures. If this strain be imposed suddenly, and especially on a heart which has been weakened by myocarditis, rapid cardiac dilatation is probable. This may lead to a fatal issue.

Careful pre-operative treatment can substantially reduce the incidence and danger of these complications. The patient should be put to bed for a week or 10 days before operation, the blood pressure recorded several times per day and a renal function test performed. A binder should be applied to the abdomen and if the hernia is irreducible it should be well padded. The binder is gradually tightened and the effect of this on the blood pressure, pulse and respiration rates, observed. The

pressure of the bandage is rapidly increased so long as it is tolerated by the patient. If there is evidence of respiratory difficulty, rapid changes in the blood pressure or pulse rate, operation is contra-indicated.

The diet should be restricted to fluids and soft solids without milk. Smith[32.] recommends beef tea which contains no nourishment but makes the patient feel that she is consuming a reasonable amount of food. He also recommends black coffee and frequent doses of epsom salts. He claims that by reducing solid food to a minimum, and giving abundant fluids, he can reduce the weight by ½ to ¾ of a pound per day.

If the renal function is poor ~~it is~~ as estimated by a urea clearance test, rest in bed, the dietetic regime and the use of a mild diuretic mixture such as pot. cit. grs. 10, sod. bicarb. grs. 20, an improvement may be expected. The urea clearance test should be repeated at weekly intervals until a safe level has been reached. This may require several weeks.

Intestinal resection in Massive Umbilical Herniae. Many authors have performed heroic resections of bowel in massive herniae in order to enable the contents of the sac to be returned to the abdominal cavity. Foss[33.] has reported 3 cases where extensive intestinal resection seemed the only solution. In each a satisfactory result

was obtained and in one of them 7 feet of ileum, the caecum, ascending and transverse colons together with a large portion of omentum, were removed. Foss was able to collect 48 cases of excision of very large portions of ileum. The largest was reported by Brenner in 1910, when he successfully removed 540 c.m.s. Others have been reportee by Dressman[34], Harris[35], Kirkwood[36], Kukula[37], Maiyake[38], Obalinsky[39], Pauchet[40], Payr[41], Shepherd[42], Storp[43] and Turck[44] in addition to the 3 reported by Foss.

TABLE XVII.

RESECTION OF ILEUM.

Operator	Length of section resected, centimetres.	Part resected.	Result
Dressman (1899)	215	Ileum	Recovery.
Shepherd (1898)	234	Ileum	Recovery.
Kukula (1900)	237	Ileum	Recovery.
Harris (1902)	239	Ileum	Recovery.
Kirkwood (1915)	240	Intestine (Part of ileum)	Recovery.
Payr (1902)	265	Ileum	Recovery.
Maiyake (1912)	238	Intestine (225 cm. ileum and 13 cm. colon)	Recovery.
Obalinsky (1894)	365	Ileum and caecum.	Death in 28 hours.
Turck (1914)	371	Ileum and colon.	Recovery.
Pauchet (1905)	400	Ileum	Recovery.
Storp (1907)	510	Small intestine (Entire ileum and part of jejunum).	

46.

Brown and Masterman reported two successful cases of excision of the transverse colon associated with strangulation in a massive hernia containing a large amount of omentum.

During such a formidable operation every means must be used to maintain the patients vital forces. A continuous intravenous glucose saline drip should be administered during and after the operation. The theatre should be warm, and if possible the table heated. Two assistants are desirable and the anaesthetic should be in the hands of a skilled anaesthetist. During the period that the abdomen is open, the patient should be kept as light as possible and relaxation can be facilitated by infiltration of the abdominal wall with local anaesthetic.

Several writers have commented on the slight degree of shock which such formidable operations produce, and have suggested that the splanchnic system may have become innured to rough usage during the long residence of the bowel within the hernial sac, when it was liable to repeated and unavoidable trauma and also increasing traction upon the mesentery.

During the first few post operative weeks there may be annoying diarrhoea. This may persist indefinitely, but in lesser degree, the patient having 2 to 3 stools

per day.

Resection of a large portion of the absorbing area of the alimentary canal, results in marked metabolic disturbances chiefly shown by rapid and pronounced loss of weight. This rarely is so severe as to prejudice a good standard of health and in obese subjects the loss may be an advantage.

Where there are very numerous intrasaccular adhesions in a large hernia, it may prove more speedy to resect the entire contents and perform an end to end anastomosis, than to undertake the extensive and intricate dissection necessary to free the contents of the sac from their adhesions. Reduction in the operation time is one of the main considerations to a successful result and smooth convalescence, but these heroic procedures are not commended save in exceptional circumstances and in the hands of skilled surgeons.

Death Rate. The estimated death rate for operations on massive herniae has been placed at 6%,[31.] but Hewitt[50.] gives it as almost 50% in really large cases.

INJECTION TREATMENT.

Watson and Meyer have stated that the injection treatment for the cure of umbilical hernia is satisfactory in properly selected cases. It is absolutely contraindicated in the following conditions.

1. Massive umbilical hernias.
2. Hernias difficult to reduce.
3. All hernias which are irreducible.
4. Hernias which can not be maintained in reduction by a truss.
5. In very obese subjects.

These contra indications embrace by far the larger number of all adult umbilical cases and though I have no experience with the method of injection, I feel that it is entirely unsuitable as a general principle for adult umbilical herniae. It may have a place in selected cases in thin subjects or in children, but in these people operation is likely to give a good result and I feel that it is probably preferable even there to injection therapy.

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CHAPTER 18.

VENTRAL HERNIA.

Definition. A ventral hernia is a protrusion of an abdominal viscus through the anterior abdominal wall and occurring at other than the inguinal, femoral or umbilical areas. They may be broadly divided into two groups, spontaneous and traumatic.

The condition has been recognised for many centuries. Guy de Chauliac was the first to differentiate umbilical hernia from ventral.[1.]

CLASSIFICATION.

These herniae may be spontaneous or follow operation.

Spontaneous. Spontaneous ventral herniae arise unrelated to operation incisions. They may be classified as:

(1) Epigastric.
(2) Divarication of the recti.
(3) Herniae in the linea semi lumaris.
    (a) Appearing above the deep epigastric artery.
    (b) Appearing below the deep epigastric artery.
(4) Herniae in the linea transversa.
(5) Herniae appearing through the anterior abdominal wall in relation to congenital muscle defects.
(6) Spontaneous lateral ventral herniae.

Acquired. These follow trauma which may be accidental or deliberate and usually relates to operation. They may be classified as:
(1) Through midline incisions.
(2) Through transrecti incisions.
(3) Through oblique incisions.

EPIGASTRIC HERNIA.

Definition. An epigastric hernia is a protrusion of omentum, fat or other abdominal viscus through the linea alba.

Classification. Terrier[2] classified epigastric herniae as:

(1) Extra peritoneal lipomata.

(2) Lipomata associated with a peritoneal sac, and containing omentum.

(3) Omental hernia without a lipoma, and,

(4) A peritoneal sac containing omentum and intestine.

ETIOLOGY.

The anatomy of the linea alba has already been described in some detail in relation to the section on umbilical hernia. So far as epigastric herniae are concerned, the important anatomical point is the penetration of the linea alba from within out by small blood vessels, and the fact that in this area there is usually a fairly thick layer of extra peritoneal fat.

A small lobule of fat may insinuate itself through the linea alba in relation to the opening for a blood vessel, either as a result of increased intra abdominal pressure or, in these cases where there is an abnormally large opening for the blood vessel, as a result of a congenital defect in development.

Small gaps in the linea alba may also be found apart from blood vessels in consequence of some congenital developmental defect.

When such a small lobule of fat has gained admission to one of these openings, it increases the diameter, penetrates the linea alba and forms a small protrusion in the subcutaneous tissues of its anterior aspect.

The herniae are more often found in persons engaged in heavy manual labour, and in my experience are more common in males.

The properitoneal fat lobule later drags with it a tent like projection of peritoneum in a proportion of cases, which is capable of forming a true hernia. In the absence of this sac there is no true hernia.

SEX INCIDENCE.

Battle[3] and Baegeli[4] state that epigastric hernia is rare in women, and Baegeli in a series of 71 cases found 94.4% in men. In my own small series of 7 cases there was only one female.

SYMPTOMS AND SIGNS.

These herniae are encountered in the midline of the abdomen usually above the umbilicus and anywhere between that point and the ensiform cartilage. The patient is

most usually a male, and engaged in heavy work. They are often small, multiple, and generally irreducible. Watson has stated that in 75% of cases they are symptomless.

The characteristic symptom is pain, which may be either neuralgic or colicky, associated with nausea, occasional vomiting, and aggravated by food.[31.]

Alteration in posture may secure temporary relief from the pain. It may also be relieved by vomiting, and is aggravated by any increase in extra abdominal pressure.

The pain is most acute in the epigastrium, but may be referred to the lateral aspect of the abdominal wall, simulating appendicitis, to the lumbar region, or, rarely to the thorax. There is sometimes a "dragging sensation" in the upper abdomen which has been attributed to traction on the peritoneum in consequence of the presence of a small sac.

On palpation of the swellings there is local neuralgic pain which may be quite severe and any attempt at reduction of the swelling will frequently cause acute pain with distress to the patient.

The swellings resemble a pea or bean in size and shape, and can be palpated in the subcutaneous tissue along the line of the linea alba. They are frequently fixed at their base and almost always irreducible. The larger herniae usually have less pain and may be as large

as a chestnut. They may then overlap the rectus muscle. The actual hernial opening is rarely in the midline, but more frequently to the left of it.

The swellings are most common in the middle third of the linea alba above the umbilicus, and less frequent in its upper and lower extremities.

It is important to examine the patient in the erect posture when a very small hernia may be seen in profile on coughing.[5.]

There is one special sign which is often of value, and described ordinarily by Litten. The patient stands erect with the epigastrium thrown forwards. The examiner places his hand over the linea alba above the umbilicus and instructs the patient to cough. If herniae are present a characteristic vibration is felt, which has been likened to liquid being thrown against the hand. Litten considered that this sensation was due to the presence within the sac of small lobules of fat, which were forced outwards by the impulse of coughing, or, to the presence in the sac of intestine containing fluid.

Gussenbauer[6.] has described how the 5 intercostal nerves, which pass through openings in the linea alba, may be subjected to pressure by these small epigastric herniae causing severe pain over the distribution of the nerve involved.

Hurst[7] described a feeling of distension often associated with aerophagy, which follows an attack of severe pain, and he has commented on the severity of the pain which may require morphia for its control. He has also described the experiences of one of his patients who found that he had fewer attacks of pain when eating lobster and pickled pork than when on a milk diet. Smidt[30] has stated that only by laparotomy can it be made certain that a gastric or duodenal ulcer does not underlie an epigastric hernia.

COMPLICATIONS.

It has been stated that strangulation never occurs or at any rate, is very unusual. A considerable number of cases have been reported in the literature however, and amongst the important papers on the subject are those of Smyth[8], Fraser[9], Ridgeway[10], Moschcowitz[11], Sebba[12], Fabre[13], Hotchkiss[14], Dujarier[15] and Berger. The age of these patients varies up to 100 years.[9] This female centenarian recovered after operation for strangulation of a knuckle of transverse colon and omentum.

True strangulation can only take place in the 3rd and 4th types of epigastric hernia, where there is a true peritoneal sac. Most frequently there is no sac and even when present it is rarely large enough to accommodate any

large viscus. Moreover, the peritoneum in the upper abdomen and relating to the linea alba is fairly tense by comparison with the relatively flaccid peritoneum of the lower abdomen. This renders the formation of a sac less probable, and when once present the viscera most liable to be implicated are the omentum and transverse colon.

Berger[16] found in a series of 116 cases only 12 which were irreducible. In my own experience each case was irreducible and I think that this complication is very much more frequent than some writers would have us believe. At operation one finds as a rule, a very small opening and a lobule of fat passing through it by a very narrow pedicle. In such cases it is manifestly impossible to reduce the swelling, and they constitute by far the larger number of cases.

OPERATIVE TREATMENT.

The treatment consists essentially of a vertical incision over the midline and exposure of the hernia. The sac is then excised and the defect in the linea alba repaired. Several points require further description.

Incision. The incision may be vertical, but in my experience it is often an advantage to make it slightly covered, so that a flap may be turned over and a more

efficient exposure of the area achieved. This also obviates any necessity for retraction. The curved incision is especially valuable when the herniae are multiple and where they overlap the rectus sheath.

Size and Nature of the Hernia. The size of these herniae varies from a small pea to a chestnut, and the treatment depends partly on their size, but more especially upon their nature. If the hernia has no sac, and the swelling consists entirely of a small lobule of fat communicating by a narrow pedicle through the linea alba with the extra peritoneal fat of the abdomen, the treatment is simple freeing of the pedicle of the lobule, ligating it with its accompanying vessel and removing the excess fat. Where the swelling consists of fat plus a sac, it is necessary also to excise the sac at its neck, having first reduced its contents and opened it to verify that no tag of omentum or knuckle of bowel is present. In every case, the presence of a sac should be suspected, and considered to be present until otherwise proved by careful dissection and examination. It is improbable that any peritoneal sac will relate to the smallest type of epigastric hernia, but where the opening in the linea alba is more than usually large and where the pedicle is broad, it should be suspected and sought.

EXPOSURE OF THE HERNIAL RING.

When the skin flap has been reflected, all subcutaneous fat should be carefully swept off of the linea alba and any rectus sheath which has been exposed. By so doing, the herniae will be exposed and freed from their slight adhesion to the surrounding subcutaneous fat. In view of the fact that these extra peritoneal fat lobules push before them a covering of fascia transversalis, they are readily stripped from their surroundings. The lobule should then be gently seized in Allis tissue forceps and mobilised until the pedicle has been clearly exposed. This is readily done by gauze dissection. Where there is no sac the pedicle is very slender and passes through a narrow ovoid opening in the linea alba. This opening is the hernial ring and must be clearly exposed. Traction should then be made on the hernia in order to stretch the pedicle. A blunt dissector or pair of fine artery forceps may then be used to free the pedicle throughout its length from any loose attachments to its surroundings. When this has been done the pedicle should be rendered taut, and transfixed as near the base as possible, and the base with the accompanying blood vessel ligated. The redundant portion is excised and the stump of fat retracts back into the abdominal cavity. There is sometimes a tendency for the hernial ring to narrow

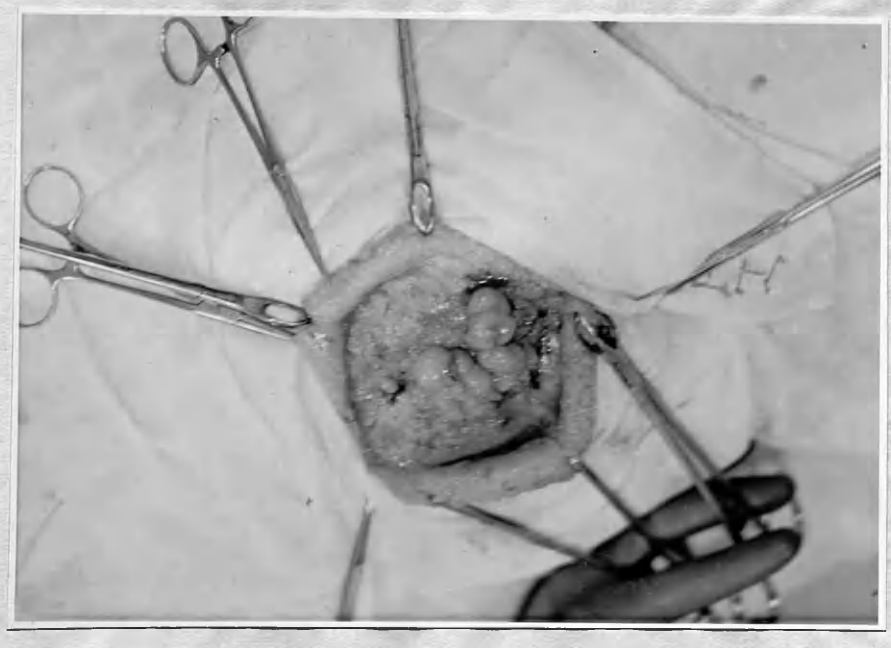

Figure 95.

Exposure of Multiple Epigastric Herniae.

when no longer stretched by the pedicle. The opening should be marked, and if small, the edges rawed by a knife and approximated by one or two stitches of chromicised cat gut. The same procedure is adopted with any other lobules which are present. There are generally two or three, and in one recent case of my own, there were as many as seven. One was very large and another as large as a half pea.

In cases where the pedicle is broad, the fat should be carefully dissected and any sac which may be present clearly exposed. This is then dissected from its surroundings and once again the hernia identified and freed.

Disposal of the Sac. The sac having been completely exposed and the neck identified, it should be opened at the fundus. Any adhesions within are freed and should the contents be irreducible, they are mobilised and returned to the abdomen. It may be necessary slightly to enlarge the opening in the linea alba in order to ensure ligation and excision of the sac flush with the parietal peritoneum. When this has been done the final stage in the operation remains to be performed.

Closure of the Hernial Ring. The edges of the ring should be freshened and an overflap type of repair performed after the fashion of the Mayo repair in umbilical

cases. The anatomy of the region is suitable for other reinforcing methods should they be necessary, and it is easy to reflect medially a portion of the anterior sheath of one of the rectus muscles and lay it over the potentially weak area of the linea alba, anchoring it in position to the linea alba and the medial aspect of the anterior layer of the rectus sheath on the other side. The operation is concluded by bringing the skin edges together with some interrupted sutures.

CRITICISM OF THESE OPERATIONS.

The overlap operation is suitable in cases where the defect in the linea alba is large, say more than ⅓ of an inch in diameter, but it is not easy to perform such an operation where the opening is small.

Again, these herniae are frequently multiple and the openings vary in size. Some are capable of closure by the overlap method and others by freshening of the edges and apposition by interrupted sutures. If it is decided to reinforce the area by a flap of rectus sheath it is generally necessary to fashion a flap three or four inches long by one to two inches broad. The size depends upon the number and situation of the openings in the linea alba. I have seen cases where one related to the upper fourth and the lowest to the lowest fourth.

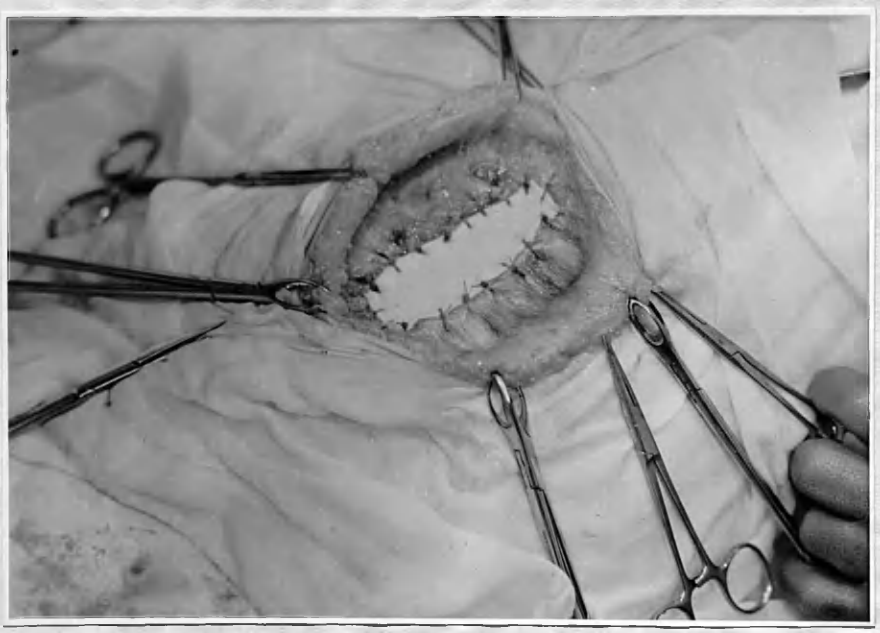

Figure 96.

Skin Graft inlay for repair of multiple epigastric herniae.

If they are confined to the central area such a large flap is not necessary. It is common to see several very minute lobules of fat at operation appearing on the surface of the linea alba and not recognised clinically. These have the characteristics of very minute epigastric herniae and if left alone may grow to cause further symptoms. Under such circumstances, I think it is wise to make a generous incision throughout the length of the linea alba and free its deep aspect from any attachment to extra peritoneal fat, and then formally close the incision. The area can then be reinforced by other means such as a flap of rectus. In three cases I have used a whole skin graft instead, stitching it above and below to the linea alba and laterally to the rectus sheaths. The results have given complete satisfaction and I think that this step is indicated either where there are multiple herniae or where any opening is large enough to merit an overlap operation. In the cases where I used the skin graft, each opening was first closed by a method suitable to its size and the skin used as a final reinforcement. No complications followed the use of the method.

TREATMENT OF STRANGULATION.

The same principles of treatment are observed as apply to strangulation elsewhere. A conservative life

saving operation is indicated. I have encountered no example of strangulation myself, but have already referred to reported cases in the literature.

DIVARICATION OF THE RECTI.

Separation of the recti below the umbilicus associated with thinning of the linea alba is a comparatively common condition, but when severe in degree there may be a bulging of the abdominal viscera between the recti on straining. This is not a true hernia but more comparable with the diffuse type of direct hernia.

Classification. The condition is found in children and adults. The diastasis may be above or below the umbilicus and rarely a special type called the supra pubic hernia of Veockler has been observed.[17.]

Etiology. Rarely in infants the linea alba may be very thin or abnormally broad and associated with a degree of separation of the recti. There may thus be a congenital anatomical condition predisposing to a development of a swelling on straining.

Obesity, rapid emaciation and any chronic abdominal tumour predisposes to the condition. It is probably more frequently associated with numerous pregnancies following rapidly upon each other.

Sex Incidence. It is most common in females.

Signs and Symptoms. Generally the condition is comparatively symptomless, but in children a bulge may be noticed on coughing.

In a typical adult case the patient is a multiparous woman and obese. There may be a feeling of weakness in the lower abdomen and unless it is supported by a stout corset, a bulging in the midline which extends from the umbilicus to the pubis. This swelling may be covered only by skin, very atrophic linea alba, attenuated fat and peritoneum. The contents may be uterus or all or any of the movable abdominal viscera. The uterus may be present during pregnancy.

On examination the margins of the separated recti are palpable well lateral to the midline of the abdomen and separated by an obvious weak area through which there is a generalised bulge on straining. It may be possible in a spare subject to see visible peristalsis.

When the patient lies prone and is instructed to raise the shoulders and head, the margins of the recti are readily palpated and the bulge between made manifest.

In the supra pubic hernia of Veockler, the swelling is in the midline above the pubis and more localised. It may be likened to the funicular type of direct inguinal hernia. Several cases have been reported in the

literature. The condition is often painful.

Complications. These are rare as there is really no neck to the sac and the condition is an eventration rather than a hernia.

Treatment. The treatment consists in reconstituting a linea alba by uniting the medial margins of the rectus sheaths in the midline.

It is preferable to use a long strip of fascia lata for the purpose, interlacing it back and forth between the medial margins of the recti on either side from the symphysis pubis upwards.

I have not used the skin graft repair for this condition because I have not met a case which required operation during the past year and a half, but I will use the skin technique if the opportunity comes my way, as it seems a satisfactory method of maintaining the recti in position. The skin would be sutured under maximum tension to the recti sheaths between the umbilicus and the pubis, after they had been united together by a continuous stitch of chromic cat gut.

After Treatment. It is necessary to advise the patient against further pregnancies lest the condition recur.

HERNIA IN THE LINEA SEMILUNARIS.

Classification. These herniae are classified according to whether they emerge above or below the deep epigastric

artery. The former is more generally known as a direct inguinal hernia. The other variety, above the deep epigastric artery is extremely rare. Amongst the reported cases is one by Battle[18.] which emerged through an opening the size of a number 16 catheter. The sac contained omentum and small intestine and was located deep to the aponeurosis of the external oblique.

Anatomy. The linea semilunares each extend from the cartilage of the 9th rib to the spine of the pubis, and correspond to the lateral margin of the recti muscles. They are arched fibrotendinous lines and united with the linea alba, through the substance of the rectus muscles, by the lineae transversae.

Site of Hernia. The linea semilunaris on either side is related to the deep epigastric artery in part of its course and at approximately the same level, also to the semilunar fold of Douglas. That is the lower margin of the posterior aspect of the rectus sheath. Herniae which appear at this level, below the epigastric artery are located in Hesselbach's triangle, and are more frequent. Those above the artery are rare and it is exceptional to find any above the level of the umbilicus.

The weak area is the lower fourth of the rectus muscle posteriorly, owing to the deficiency in the sheath. The hernial opening is usually situated along the line of

the semilunaris in that part.

Coverings of the Hernia. The swelling is overlaid by extra-peritoneal fat, fascia transversalis and one or more of the anterolateral muscles of the abdominal wall. At first the sac is interstitial, but in an advanced case it may penetrate to the subcutaneous area and be located immediately below the skin. The neck always relates to the lateral aspect of the rectus sheath. When it has gained either the subcutaneous or subaponeurotic layers of the abdominal wall, it may expand in all directions. The sac thus tends to be mushroom shaped.

There is almost invariably a related properitoneal mass of fibro fatty tissue.

Contents of the Sac. Omentum and small intestine are the organs most frequently found.

Signs and Symptoms. The condition is difficult to identify in its early stages, but varies in no respect other than situation in its characteristic signs and symptoms.

Complications. The hernia is liable to the same complications as any other, and treatment is on the same lines.

Treatment. The lesion is dealt according to the usual principles of total excision of the sac, closure of the hernial ring, and repair of the weak abdominal wall.

(4) HERNIAE THROUGH THE TRANSVERSA.

The lineae transversae partially intersect the rectus muscle in three places and hernia through them have been described by Battle[18.] and Watson.[19.]

These are very rare and most frequently found in old age.

(5) HERNIAE THROUGH CONGENITAL MUSCLE DEFECTS.

Occasionally cases of congenital absence of certain of the anterolateral abdominal muscles have been described. These have sometimes been associated with the development of congenital spontaneous lateral ventral hernia.

In that described by Leo-Wolf[20.], a child of one year and nine months exhibited ventral herniae on both flanks when sitting up or standing, and, when recumbent, presented a relatively normal abdomen with only very slight bulging in the flanks. Examination showed that the external and internal oblique as well as the transversalis muscles, were absent from both sides. Both abdominal recti and latissimus dorsi were normal. The abdominal organs could be readily palpated through the skin.

Steinhardt[21.] and Parker[22.] reported similar cases. Osler,[23.] Bolton,[24.] and Smith[25.] have reported other congenital muscle difficiencies associated with hypertrophy of the

bladder and ureters.[26.] Finally Wyss described a partial defect of the external and internal oblique and transversus abdominis muscles in a child aged ten months, associated with ventral hernia. These conditions are probably best dealt with by carefully chosen supports. Usually the defect is too great to permit of any worthwhile plastic operation.

(6) SPONTANEOUS LATERAL VENTRAL HERNIAE.

These have sometimes been classified under the heading of hernia through the linea semilunaris, but Cooper[27.] believed they escaped through one of the small openings for blood vessels penetrating the anterolateral abdominal muscles. This view has been supported by others and in one case of my own, the opening was at least two inches lateral to the lateral border of the rectus sheath. The hernia was spontaneous and no cause could be found to explain its origin. I believe that it was an example of the type described by Cooper. These are rare and predisposed to by muscle paralysis most frequently due to acute anterior polio myelitis. Other factors are multiple pregnancies, obesity, marked abdominal distension and advanced emaciation. My case was in a stout multiparous woman.

ACQUIRED VENTRAL HERNIA.

Synonyms. Incisional or post operative herniae.

Classification. These may be classified according to the incision through which they emerge, but may broadly be classified as those appearing through midline, transrecti, or oblique abdominal wounds.

Etiology. All surgeons are agreed that any abdominal operation requiring drainage is more likely to be followed by weakness in the scar than after primary closure. These herniae are frequently seen through incisions which have been made for the drainage of appendix abscess. They are also common after midline supra umbilical incisions for the repair of perforated peptic ulcer. In fact, any incision through the linea alba, even with the most meticulous repair may be followed by yielding. There are special reasons why scar tissue may stretch when it enters into the formation of the abdominal wall.

(1) Intraabdominal tension varies with different times of the day and from day to day, but increases with age and the acquiring of more sedentary habits.

(2) The acquiring of sedentary habits and increase in weight with advancing years, causes a relative weakness of the muscles of the abdomen.

(3) Where the abdomen is stout, increase in pressure tends to be referred in greatest degree to the most prominent part. Therefore midline

incisions are prone to stretching, as the linea alba is the stay which unites the powerful muscles of either side.

When the abdominal muscles contract the tendency is to broaden the linea alba, and, if this has been weakened by scar tissue, to stretch the scar. Ill-effects of inflicting a wound through the structure of the abdominal wall may be minimised by a technique which will avoid unnecessary damage to tissues, ensure the maximum degree of preservation of nerves and be mechanically planned so as to leave as strong an area as possible. The most favourable types of abdominal incision from the point of view of strength of scar, are the paramedians and the oblique gridiron incisions, where it is possible to penetrate the abdominal wall in layers which will overlap each other when the wound has been reconstituted.

It is mechanically bad to make an incision along the lateral border of the rectus muscle, as it is to the linea semilunaris that the anterolateral muscles insert. If the point of insertion into the rectus sheath is weakened by scar tissue this may be stretched by contraction of these powerful muscles, the pull of which is backwards and away from the midline.

When, for any reason a scar is stretched to leave a weak spot or, when closing a wound a defect is left through which a minute portion of mentum may pass, a hernia may

probably develop. Omentum has the power of finding and dilating the most minute weak area.

It is essential to close all abdominal wounds by perfect apposition of their edges through the whole length of the incision.

In closing the peritoneum it is necessary to avoid the inclusion of a piece of omentum in the suture line, as this may further insinuate itself into the scar to cause a hernia.

The paramedial incision, through which the anterior layer of the rectus sheath is opened just lateral to the midline, the rectus muscle mobilised and retracted laterally, and the posterior sheath opened on a different plane from that of the anterior, gives a mechanically strong scar when reconstituted. This incision should be used in preference to those through the midline wherever possible. An incision through the linea semilunaris may destroy a portion of the nerve supply to the related rectus muscle and predispose to later ventral hernia.

Muscle fibres should be separated and retracted where possible in opening the abdomen, and never cut unless such a step is essential to the particular requirements of the case.

Much has been written concerning the relative merits of absorbable and nonabsorbable suture material in

relation to deep post operative sepsis and strength of scar. A great volume of opinion favours the one type and an equally influential volume of opinion favours the other. Any expression of thought in the matter by myself is not going to affect the use of one particular kind of suture in preference to another, but in my view it is not justifiable to use buried non-absorbable sutures at the present time, except under certain special circumstances. The disadvantages lie in the possible development of late sepsis. In my own experience this has occurred on a few occasions after the use of buried silk or linen, and I have removed portions of these stitches on at least 20 occasions from wounds made in soldiers by other people. In my series of inguinal herniae the only recurrence with the skin method owes its being, I am sure, to the sepsis which developed and was found at later operation persisting in relation to each linen stitch. On the other hand, the old objections to cat gut and its possible association with anthrax are no longer tenable. Good quality cat gut is prepared with meticulous care, supplied in convenient lengths, carefully tested and in strengths and diameter to meet every possible requirement.

The controversy between the two schools of thought has waged for many years and will probably continue for many more. I think that each individual surgeon must

work out the problem for himself and use the material which he finds most ideal in his own hands.

Fairfield[33] has suggested that violent post operative vomiting is the most important cause of later incisional hernia.

Incidence of Post-Operative Ventral Hernia. Stanton[28] investigated the incidence of hernia after 500 laparotomies. Of these, 456 were performed through midline or paramedian incisions and followed by 21 hernias. At operation on these, each was considered to be due to poor union of the fascia layers lying anterior and posterior to the rectus muscles. Stanton believed that the fascia deep to the rectus is the first line of defence in prevention of later hernia. Of 260 clean cases only 3 post-operative hernias developed, while in 186 infected cases 18 resulted.

Warren[29] reported one thousand appendicectomies through a gridiron incision and found 2% post-operative hernias.

Signs and Symptoms. These swellings vary in size from a walnut to a pumpkin and may assume grotesque dimensions. They may be single or multiple, and I have seen as many as 3 in one patient appearing through a sub umbilical incision, a supra umbilical midline, and a right gridiron.

The scar of the original operation is always identifiable over the swelling. The symptoms and signs are those found with all herniae, but when in the

epigastrium may resemble those of epigastric hernia with pain similar to that of peptic ulcer. In large cases, owing to the constant presence of omentum within the sac, they are frequently irreducible, and constipation, abdominal colic and evidence of partial obstruction is frequent. These functional symptoms are aggravated by coughing, exercises and pressure.

If the patient is stout and the hernia small, it may be difficult to locate, but then there is often a localised point of tenderness on palpation which may be readily found if the subject is examined erect. If the hernia is large or multiple the diagnosis is obvious.

Even in partially irreducible cases an impulse on coughing is generally felt.

If the swelling is large, coils of bowel may be seen on inspection and, if irreducible, visible peristalsis be evident. In such cases the overlying skin is usually thin and may be atrophic. Evidence of trauma and skin irritation is sometimes seen as in the case of umbilical herniae.

The condition of these patients is frequently poor, they are often stout or subject to chronic bronchitis. They are amongst the most grateful patients after successful treatment.

Owing to the frequent association of obesity,

bronchitis and the other complications already described in relation to umbilical hernia, the same careful pre-operative treatment is necessary before any attempt is made at repair. The operation is often extensive.

Complications. This condition is subject to the same complications, and for the same reasons, as umbilical hernia. Irreducibility is frequent and partial obstruction common. Strangulation is less frequent than in umbilical cases as the ring is generally larger, but intrasaccular strangulation does occur occasionally owing to the numerous adhesions within the sac.

There is the same liability to rupture of the sac after a strain or fall.

Treatment. The treatment of ventral hernia consists primarily in excision of the scar with redundant skin, dissection out of the various layers of the anterior abdominal wall in the affected part, reduction of the contents of the sac, removal of the sac and reconstitution of the abdominal wall in layers. Owing to atrophy of tissues in large cases the structures available for closing the defect may not be sufficiently strong to ensure a satisfactory result. Then it becomes necessary to use strips of fascia to reinforce the weakened area and fascia may also be used to unite each layer of tissue from deep to superficial.

I have found in 10 large ventral cases out of my total of 17, that a strong repair could be effected by using a large skin graft plaque to reinforce the abdominal wall after reconstitution in layers. The graft chosen was always sufficiently large to cover the entire weakened area and any one example when stretched measured approximately 5 inches by 3.

Several points in technique require further consideration.

Skin Incision. This incision is planned to remove the scar and all redundant skin over the hernia. It follows that the larger the hernia the more skin must be excised and also that the larger the hernia the more skin is available for repair of the anterior abdominal wall.

Exposure of the Sac. The sac is frequently subcutaneous and overlaid only by thin skin and a layer of atrophic fibro fatty tissue. Care must be taken not to open it inadvertently while this adhering subcutaneous layer is dissected free. This dissection may be a little difficult, as old scar tissue may have caused firm adhesion to the sac.

It is necessary to dissect the sac from its surroundings when small. In large cases, the neck alone need be exposed as in the manner described for umbilical hernia. When this has been done the neck should be

traced through the abdominal muscles and separated from the surrounding ring which they form until it has been freely mobilised.

The sac should not be opened at this stage.

Identification of the muscle layers of the Abdominal Wall.

When the neck of the sac has been mobilised, attention should be paid to the muscles of the anterior abdominal wall. Each should be incised in a healthy part, free from scar tissue to open the subeponeurotic space between it and the adjacent layer deeply. When this line of cleavage has been found, the incision should be prolonged almost to the hernial ring, thence around it and prolonged on the other side. The flaps of external oblique muscle thus formed should be raised, and similarly also the internal oblique and transversus abdominis gently separated from any adhesion to underlying parietal peritoneum. The fibrous margins of the ring are then removed from healthy muscle to expose the point at which the neck of the sac joins the investing layer of parietal peritoneum.

Opening and Excision of the Sac. Approximately one half inch above this level the neck should be incised circumferentially and the sac generously laid open. Intrasaccular adhesions and redundant omentum are dealt with as already described in relation to umbilical hernia. Other

contents are reduced into the abdominal cavity and the sac with its attached redundant skin and subcutaneous tissue removed. The portion of the fibrous hernia ring which has been freed from healthy muscle is also removed.

Reconstitution of the Abdominal Wall. The various layers, peritoneum, fascia and muscle are individually closed with interrupted sutures. Two "o" cat gut is suitable for the peritoneum and fascia, and 30 day chromicised number 2 or 3 cat gut for the other layers.

If necessary, fascia may be used instead of cat gut to unite the muscles, and as a final step may be darned and interlaced through the aponeuroses of the external oblique muscle.[32.] As an alternative to this, a plaque of skin may be sutured under tension to the surface of the anterior sheath of the rectus, and thence laterally over and on to the external oblique aponeuroses.

Lipectomy. As ventral herniae are frequently associated with obesity, lipectomy is often indicated.[32.] It is performed as already described in the section on Umbilical hernia and is particularly well borne in the young.

Type of Hernia. The above description applies to a ventral hernia through the anterolateral muscles, but similar principles are observed in all types of ventral hernia. Where the sac is through the linea alba it is

essential to unite the margins of that structure not with cat gut, but with fascia. Alternatively if cat gut is used skin should be superimposed as described for epigastric hernia and divarication of the recti.

Ventral hernia through the rectus muscle is uncommon, but when found should be dealt with according to the principles detailed.

Post operative Treatment. The patient should be confined to bed for a minimum of three weeks and thereafter instructed to avoid strain for a further six months. Women should avoid pregnancy for a further year, and on no account must have several rapidly recurring.

Exercises should be encouraged and in obese patients a diatetic regime may control the unwanted weight.

If the hernia is massive, intestinal resection may be necessary.

Results of Repair. Hook[34.] gave 14-40% recurrence after operations for the cure of ventral herniae.

I have had no recurrence in my own series as evidenced by replies returned by patients. My series is not large.

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CHAPTER 19.

SLIDING HERNIA. EXTRA SACCULAR HERNIA (HERNIA EN GLISSADE).

Extra saccular or sliding hernia is one in which some portion of the wall is formed by an organ which, in its normal position is only partly covered by peritoneum.

Caecum, appendix, ascending and descending colon, sigmoid colon and small intestine have all been described as the sole elements within such a hernia. More commonly there are several organs involved, for example, caecum ascending colon, appendix and omentum or small intestine.

Demel[1], says that about 1.2% of all inguinal and femoral hernias are of the sliding type. In my series of 450 inguinal herniae eight were extra saccular and in each the caecum was the only organ involved.

The condition was probably first described by Galen.[2] Geiger[3], commented upon it in 1631 and observed that most were on the right side. Since then very many examples have been described and the condition is well recognized. Treatment still remains something of a problem, and may at times be far from easy.

Classification of Herniae of the Large Bowel.

All cases of hernia of the large bowel found in the femoral or inguinal canals are not necessarily sliding.

Such herniae may be congenital or acquired and of three types.

Congenital. Here there is always a complete sac, the caecum has a mesocaecum and descends into a preformed sac. The organ is entirely covered by peritoneum and can readily be drawn into the sac or reduced from it. Other viscera may be also present.

Acquired. In simple acquired herniae the caecum is as in the congenital type and lies free in the sac as may omentum or small intestine. There are three varieties.

1. Intrasaccular hernia. Here there is a complete sac derived from the parietal peritoneum in the neighbourhood of the caecum. The organ may enter as a result of ptosis of the colon, the presence of a mesocaecum or ascending mesocolon, or adhesions connecting with an omentocele.

2. Parasaccular hernia. The intestine here forms a part of the wall of the sac, and lies behind it, usually to the outer side. The peritoneum covering the caecum on its anterior and medial surfaces forms the peritoneum of the posterior and external walls of the sac and continues with the peritoneum of the remainder. The peritoneum of the sac originally derives from the parietal peritoneum of the region and the hernia is acquired.

3. Extra saccular hernia. These are very rare. Watson

collected 14 cases from the literature.[4.]

ETIOLOGY.

The condition may be congenital or acquired.

For some weeks during early foetal life the greater part of the intestines lies within the umbilical cord, but between the seventh and ninth weeks they are drawn into the abdominal cavity. At this time most of the large bowel lies to the left of the mid line. With the superior mesenteric artery as an axis of rotation, the caecum passes up to the cardiac end of stomach, across and under the liver, and finally down to reach the right iliac fossa about the eighth month of intrauterine life.

The caecum may be retained in the umbilical cord, forming a congenital umbilical hernia, or it may be arrested permanently at any point along its normal route. Its reduction may be abnormal and then it may occupy a position in the left iliac fossa.

During the period of development, the asecnding colon is provided with a mesentery attached to the posterior abdominal wall, in common with the small bowel.

Usually the asecnding colon loses its primitive mesocolon before birth and gains a secondary attachment to the posterior abdominal wall in the right lumbar region by a process of fusion between the posterior parietal peritoneum

and the related leaflet of the primitive mesocolon. The two peritoneal layers then degenerate, to form areolar tissue or a thin fascial layer. That leaflet of the primitive mesocolon which originally directed medially (anterior leaflet) becomes the posterior parietal serous covering. The ascending colon thus acquires a position usually described as retroperitoneal.

After the primitive ascending mesocolon has disappeared the colon is closely apposed to the posterior abdominal wall. It may retain this position, or in later life the peritoneum on either side of the colon may elongate to form a definitive ascending mesocolon.

The anterior surface of the caecum when distended lies in contact with the anterior abdominal wall, and customarily bears an intimate relation to the internal ring.

Infrequently the peritoneum on the posterior surface of the caecum undergoes the same process of fusion as occurs with the primitive mesocolon. Thus the caecum may acquire an extraserous position. According to Jonnesco[53.] this happens in 8 per cent. of cases, but it is considered a much rarer anomaly by most modern anatomists. In a series of 400 appendicectomies performed by myself the caecum was extraserous in only 4 cases.

Factors leading to descent of the caecum.

1. The mobility of the caecum and its proximity to the

internal ring permit its entrance into a patulous vaginal process, before or after birth, to form a congenital inguinal hernia. The caecum itself is then clothed throughout by peritoneum and lies within the sac. The contents of the sac may be caecum and appendix only, or there may be also parts of the ascending colon, small intestine, and omentum.

2. The caecum may be actively drawn into the vaginal process by means of abnormal gubernacular connections with the testicle.

56.

In a young infant Lockwood found muscular fibres of the gubernaculum extending above the testis to insert into the caecum and posterior parietal peritoneum. His claim that these muscular fibres may play an important role in causing a hernia of the caecum has been confirmed by other writers.

3. When the caecum descends to the iliac fossa as early as the fourth month, adhesions may form between the caecum or appendix and the posterior parietal peritoneum covering the testis or gubernaculum. Later descent of the vaginal process and testis will draw the caecum into the inguinal canal, and form either a congenital or infantile hernia.

By either the second or third mechanisms, the caecum may be drawn down to form a congenital sliding hernia of either intrasaccular or extrasaccular type.

Acquired Caecal Hernia. Acquired hernia of the caecum may be classified as simple or gliding. The latter, called by the French "hernie par glissment", may be sub-divided into (a) the intrasaccular; (b) the extrasaccular and (c) the sacless.

The simple acquired caecal hernia is analogous to acquired hernia of small intestine or omentum. The herniated caecum possesses an intact peritoneal coat and lies within the sac.

(a) In gliding intrasaccular caecal hernia the caecum has a mesentery which appears to be inserted in the wall of the sac. A circumnavigating finger encounters the obstruction due to it when exploring the opened sac.

(b) In extrasaccular hernia the caecum is not contained within the sac, but lies on its postero-external wall, and can be exposed without opening it. The posterior and external walls of the caecum are devoid of serous covering and lie in direct contact with the cellular tissues of the inguinal canal and scrotum. The peritoneal coat on the antero-internal surface of the caecum forms the postero-external wall of the sac and is directly continuous with the remainder which derives from parietal peritoneum. A complete sac can be found in every case in front and to the inner side of, or above the caecum.

(c) Sacless Hernia. The caecum may emerge from the

internal ring minus its own serous covering, absolutely unrelated to a sac, and without producing a rent in the parietal peritoneum.

The gliding caecal hernias are produced by a ptosis or downward gliding not only of the caecum but also of the colon, its attachments and vessels, and the posterior parietal peritoneum. Baumgartner has shown that there may be in addition a downward displacement of the kidney on the same side, due to its peritoneal attachment, and of the aorta and inferior vena cava, due to their vascular connection with the affected gut.

The caecum may escape from the abdominal cavity secondarily to another organ. (1) The distal end of the ileum may form the hernia and by its descent pull upon the caecum to drag the latter through the hernial ring. (2) A hernia of the small gut or omentum may with increases in size, drag the posterior parietal peritoneum with the colon and caecum down into the sac. The anterior parietal peritoneum is more firmly attached to the abdominal wall than is the posterior parietal peritoneum. An enlarging hernial sac is thus provided at the expense of the posterior parietal peritoneum, which in turn exerts traction on the caecum. (3) The caecum and colon may descend so that the posterior surface of the colon may be the first part of the gut to escape from the hernial opening.

It thus forms an angle with the caecum which will be dragged into the hernia by its colonic end (Tuffier's "hernia par bascule"). If the caecum retains its serous coat it will occupy an intrasaccular position and the colon may be either intrasaccular or extrasaccular, depending upon whether it possessed a mesocolon or was extraserous before descent into the hernia.

About 16% of the reported cases of all varieties of inguinal hernia of the caecum were found on the left side. Foerster in 1901 was able to collect 54 cases of left caecal hernia.

The relative frequency of the various forms of hernia of the caecum is indicated by combining the statistics of Hildebrand[56.] and Gibbon[57.], who have collected 139 and 63 cases respectively, only 4 of which are duplicated. Of their 198 cases 128 were right inguinal, 24 left inguinal, and 12 were stated to be inguinal without reference to side; 21 were femoral, 18 on the right and two on the left; one was not specified. 11 were umbilical. There was one case each of sacrosciatic and of ventral caecal hernia. In a collection of 135 cases of caecal hernia Koch found the caecum completely intrasaccular in 108, of which 86 were right and 22 left.[58.]

Femoral caecal hernia is generally found in females. Of the 21 cases of Hildebrand and Gibbon, 13 were in

females. This hernia is always acquired, and the caecum may be intrasaccular, extrasaccular, or sacless.

SEX AND AGE.

The condition shows an absolute preponderance in males owing to the fact that inguinal hernia is more common in that sex. It has also been found in females, and there is probably a proportionately higher incidence in the male. It is uncommon in childhood, but cases have been described.[14.] More frequently it is associated with adult life and old age.

Diagnosis.

This is usually impossible before operation. One possible clue is the size of the hernia. They are usually large. Rarely the appendix may be palpable within the sac. The condition tends to recur at once after attempted reduction, and reduction is rarely complete.

Symptoms and Signs.

These are as for ordinary inguinal herniae involving the large bowel, and the condition is liable to the same complications and sequelae.

Treatment.

It must be remembered at operation that no viscus which has a complete mesentery or peritoneal investment is likely to be the sliding element in a hernia. Thus the

presence of longitudinal taeniae in a viscus exposed during herniotomy does not necessarily imply that the hernia is sliding. It must be remembered that the caecum or appendix may be found within a hernial sac and the condition not be a true sliding hernia. These organs may be entirely intrasaccular.

Where a true extrasaccular or sliding hernia does exist the treatment is not easy.

It is essential to remember that the organ generally lies to the outer and posterior aspect of the sac. There is thus a real possibility of the intestinal wall being opened in mistake for the sac.

It is a wise precaution when the condition has been diagnosed to open the sac always towards its inner aspect.

An indication at operation of the presence of a sliding hernia lies in the fact that the swelling cannot be reduced without at the same time reducing the sac. When this phenomenon is observed sliding hernia should be suspected.

Whilst the inner aspect of the sac is the most usual and the safest place to incise, a good deal of individual discretion must be observed as to the best site for each particular sac.

Before opening the sac a thorough exposure of the area must be made to expose normal anterior parietal

peritoneum. A small incision is made through this area and the sac carefully clipped away from its attachments to the affected viscus. There then presents an opening in the peritoneum which should be closed by a fine continuous suture. It will be found that the caecum or other viscus may now be reduced apart from the repaired sac. The sac is then removed in the usual fashion by torsion transfixation and excision at a high level.

A large patent muscular ring and dilated canal usually remains for repair which may be performed along conventional lines with either fascia or whole skin.

Unwin[15] has advised repair by filigree wire and a step to correct mobility of the ptosed caecum or colon. He suggests that the abdomen should be opened by a small lower paradedian incision and the mobile organ anchored by sutures to the parietal peritoneum of the iliac fossa and to the fascia and muscles under it. In my opinion caecopecy or colopecy is indicated only in large cases where ptosis and mobility are considerable.

Important papers upon sliding herniae have been published by Walton,[5] Watson[6] and Moschowitz.[7]

HERNIA OF THE BLADDER.

The bladder may herniate through any of the usual hernial orifices in the lower abdomen or pelvis, or else

through an unusual site. In the sliding variety the most common situation is the inguinal region and the hernia is usually direct and extrasaccular. The organ must be large before it forms a true sliding hernia, and frequently it is a diverticulum rather than the main bulk of the viscus which is involved.

Albucasis[18] in the 11th century described bladder hernia and Sala[19] wrote of it in the thirteenth. Then followed communications by Guy de Chaulliac[20] in the fourteenth century, and Plater[21] two hundred years later. In 1769 Verdier[22] wrote a classic on the subject, but from then until 1889 practically no observations of importance were recorded. Isolated cases, mentioned by Moynihan[23] were reported by Percival Pott, John Hunter and Astley Cooper. To quote Moynihan, "the rarity of recorded examples is due, it would seem, rather to a want of pertinent observation than to the infrequent existence of cases." Brunner[24] in 1889, Aue[21] in 1891, Allessandri[25] in 1901, and Eggenberger[12] in 1908 added to the published cases. Prior to 1896 about 200 had been reported.

Brunner[24] gave the following resume of published cases.

	Herniotomies.	Bladder hernia.
Lucas-Championiere ...	275	2
Kronlein	276	1
Bassini	262	1
Habs	200	1
Corazza	105	1
Monari	223	6
Montegnacco	500	4

It is interesting to note in this connection that Floerken[27.] very recently (1922) in 83 cases of inguinal herniae found 13 per cent involving the bladder. In no known case was there any urinary disturbance.

Eggenberger[12.] found in a collection of 1841 operations for various types of hernia sixteen which were complicated by cystocele, and a total of seventy-five in a series of 6778 operations. In my series of 450 inguinal herniae only 5 were complicated by cystocele and these were all extrasaccular and direct.

Anatomy.

The bladder is normally incompletely invested with peritoneum which is most adherent to it at the base and postero-inferior aspect.

When distended it assumes a fusiform shape, but when emptied, contracts and recedes into the pelvis as a flattened cone. The anterior and lower lateral portions of the bladder are devoid of peritoneum and attached to the adjacent pelvic structures by areolar tissue. Next to the stomach it is the largest hollow viscus in the body and is suspended superiorly by the urachus, being fairly firmly fixed at its base. The organ is movable, and capable of being carried in whole or in part to any of the common hernial openings of the lower abdomen.

In hernia the organ may relate to the sac in several ways.

Relation to Peritoneum.

1. The bladder may be completely invested with peritoneum. This is always within a large inguinal hernia and through a greatly dilated internal ring.
2. There may be only a partial peritoneal investment and the organ form part of the wall of the sac medially. This is the most common variety.
3. There may be no peritoneal investment at all. Here the hernia is always direct. There may be absolutely no evidence of any sac.[9, 10, 11.] This is rare.

Roznatovski[21.] in 1910 considered the intraperitoneal type a true hernia and the other two false, whilst Hutchinson[28.] in 1923 wrote: "It is obvious that vesical hernia may be primary, i.e., the pouch alone projects through the ring (I think always the femoral in this case) and may be entirely or mainly devoid of sac." This latter variation has frequently been classified as extraperitoneal.

Moynihan[23.] in 1900 gave the following causes for possible vesical extrusion through the anatomically weak spots in the abdominal wall:

"Permanent vesical distension, the increase being also in the transverse direction thus bringing the bladder into relation with the inguinal fossae. Investigations carried out by English in 1877 suggested to him an abnormal obliterated hypogastric artery in which the premature

involution of the vessel had lead to the formation of strong peritoneal folds which rendered resistance to the backward distension of the bladder considerably greater than to the lateral. The bladder then slowly widens out and reaches the internal abdominal ring more readily than under normal conditions. Long continued overdistension would give the necessary thinning of the bladder which would permit of engagement of the organ in the internal abdominal ring."

According to the researches of Alessandri[25.] in 1901 on cadavers, when the bladder is distended with about 500 cubic centimeters the extraperitoneal portion has a greater tendency to come in contact with the inguinal and femoral rings.

It was hard for him to produce a diverticulum of the bladder by pushing on the prevesical fat, but his cadavers were not fresh. Karewski[29.] in 1905 working on fresh subjects dilated the inguinal rings and injected 100 cubic centimeters of fluid into the bladder. It could then be palpated through the hernial openings. When 250 cubic centimeters were injected the organ could be seen at the openings, but more filling did not broaden its diameter. If the prevesical fat and peritoneum were grasped and traction made, a finger-like diverticulum of the bladder could be demonstrated.

Moynihan gave as a second cause "Motor insufficiency of the bladder with atrophy of its wall", and also, and very important, "A drag upon the bladder wall by prevesical fat".

The bladder is normally surrounded, and its muscular wall often infiltrated, by fat. This prevesical fat is continuous with the adipose tissue which extends along the spermatic cord and with that which passes up into the region of the kidney. It is possible that in some examples of hernia of the bladder, traction may have been exerted on the wall by this fat to form a hernia of the lateral wall of the viscus in much the same way as a ventral hernia may be formed in the linea alba.[30] This view was held by Verdier,[22] as far back as 1769 and has since been stressed by Pellatan,[31] Monod and Delageniere[32] Gueterbock,[33] Gibson,[26] Lotheisen,[34] Baroni,[21] Beale,[35] Ferdinando,[36] Gruget,[37] Machevnin,[38] Zavyaloff,[39] Glueckstahl,[40] and Oliva.[41] Other authors Keate,[42] Lambret,[43] and Cheeseman[44] assign to the fat the function of path-finder for the oncoming bladder. Jaboulay and Villard,[11] consider that the fat does not act as a point of fixation, but favours descent of the bladder by sliding the organ from its peritoneal covering so that it is no longer fixed and may abut against the inguinal ring. Rivalta[45] in considering the etiology in his case, stressed as do most authors, the great accumulation of fat which preceded the bladder. His view was that the lipoma maintained a constant

relationship between the distended bladder and the inguinal fossae, overcame the resistance of the overlying fascia both by gliding, and by traction which favoured the descent of the organ as a diverticulum (lipocystocele). Further traction combined with pressure from within causes it to emerge from the external inguinal ring. The macroscopic appearance of the diverticulum have been emphasized by Geuterbock,[33.] Beale,[35.] and Machevnin.[38.] It is thin and long, and suggests constant traction by the lipoma over a period of years.

A number of writers believe that bladder herniae are congenital.[46. 47. 48.]

Watson has demonstrated analogous condition in the foetal bladder and Corner and Rowntree[49.] believed that their case of extraperitoneal scrotal bladder hernia in a year-and-a-half-old baby had a congenital abnormal attachment of bladder to the gubernaculum testis.

Etiology.

Ostrom[47.] considered that the primary factor in the etiology of bladder hernia is "some congenital malformation or acquired loss of the integrity of the bladder wall." He believed that many cases were explained by the presence of a congenital diverticulum attaching to a congenital sac, and increasing in size with advancing years.

Anything which dilates the hernial rings or weakens

the posterior wall of the canal favours the condition. Likewise habitual overdistension or the presence of a diverticulum favour bladder hernia.

It is a condition of adult life, and old age especially, though Watson[6.] has described one example in a child of eighteen months. It is more common in females and in Watson's series mainly between the ages of fifty and sixty. There is usually an associated cystitis or in the male, prostatic hypertrophy. In women, pregnancy is considered to be the most important predisposing factor. Watson was able to collect 30 examples in children under twelve years.[4.]

Habitual constipation may tend to lift the bladder to a slightly higher level than normal and predispose to hernia when in relation to a patulous hernial orifice.

Brunner[24.] has drawn attention to the fact that in liberating the sac of a large hernia, the tip of the bladder may be pulled into the operation field. This he designates an "operative bladder hernia".

Hernial Contents.

The bladder may be present along or with omentum, small intestine, caecum or ureter.

Rarely the entire urinary bladder excepting the trigone has been found in a hernia sac. The organ may be normal or diseased, and examples have been described where

vesical calculi were present in the sac. This is favoured by the stasis which is inevitable within a herniated diverticulum.

Prehernial Lipoma.

Frequently a soft irregular mass of fat supporting a meshwork of fine blood vessels forms a layer in front of the bladder and should be a warning to look for the underlying condition at operation. This fatty mass is a constant feature of almost all bladder herniae save in the presence of emaciation and debility. The role of this fat in etiology has been indicated.

Diagnosis.

There are at least 61 cases in the literature classified as extraperitoneal which, on close examination, have been found to be paraperitoneal.

In going over these, one is impressed by the infrequency of a correct diagnosis. Watson[4.] in reviewing 347 cases of all types of bladder hernia, concluded that the diagnosis was made as follows: Before the operation, 25 times; during operation, 279 times; and after operation, 43 times.

Extraperitoneal bladder hernia may be diagnosed before operation:

(1) by making a careful history.

(2) by the presence of a large ring.

(3) by slight impulse on coughing.

(4) by the appearance and disappearance of the mass.

(5) by the increase in the size of the hernia with a full bladder.

(6) by the fact that pressure on the hernia may cause micturition or passage of urine along the urethra.

(7) by injections of 8 per cent potassium iodide or 10 per cent potassium bromide into the bladder to make possible X-ray of the diverticulum, and

(8) by cystoscopy.

Symptoms and Signs.

Symptoms of bladder hernia are often obscure.

They refer chiefly to disturbances in micturition. Frequency and urgency or lack of control are common. Characteristically the bladder may be emptied in two stages. The patient first empties the pelvic portion of the organ, then on pressing the swelling or altering the posture the urine in the hernia flows into the main part of the organ and is voided. In cases described by Petit[9.] and Justo[10.] the patients had to lie down to empty the bladder. The swelling then diminishes in size.

Sometimes fluid can be felt in the hernia. There may be a thrill and usually an impulse on coughing. If bladder alone is in the sac, the percussion note is dull.

Bladder hernia in males is often irreducible,

especially if it is large and of the scrotal type. Sometimes other contents in the sac can be reduced, leaving a firm mass, which, when lifted up with the fingers or compressed, becomes softer, and fluid can be felt flowing into the pelvic bladder.

A sound can often be passed into the hernia and the tip of it felt just beneath the skin. The bladder can be inflated with air; if bladder is in the sac, it will increase in size, become tense, and give a tympanitic note on percussion. Cystoscopic examination may show an internal opening if a diverticulum is in the hernia; this opening may be very small.

Rectal examination is important. The normal bulging of a distended bladder toward the rectum is absent in bladder hernia where the hernia is large.

Complications.

Calculi in the herniated viscus have been described, and calculus formation is predisposed to by the presence of urinary statis within the organ. Any pathological condition which affects the bladder may be observed. Tumour has been found, but more frequently tuberculosis.[59.] This may spread to involve the sac.[11.] Strangulation has been described at all ages from early infancy onwards.[50.51.52.53.] Sudden and prolongedurinary retention plus a herniated diverticulum may cause strangulation.

Signs and Symptoms of Strangulation.

The symptoms are different from those of intestinal strangulation and the condition is much less frequent. Colicy pains are felt in the hernia and may radiate into the thigh.[60.] Disturbances of micturition follow early and urinary retention is common. The urine may contain rank blood.

There is local pain and tenderness over the tumour which is hard, tense and may show inflammation of the overlying skin.

Reflex phenomena may be noted with epigastric colic, vomiting and even diarrhoea.

The general condition deteriorates in the absence of treatment and peritonitis complicates the terminal phases.

Prognosis.

Hernia of the bladder does not jeopardize the life of the patient unless strangulation occurs. This is uncommon.

In 241 cases collected by Eggenberger,[12.] the mortality was 6 to 12 per cent. where injury to the bladder was recognized at operation; and 31 to 40 per cent where it was not discovered until after operation.

Treatment.

Operation is the treatment of choice for hernia of the bladder. A truss can not be worn with safety and rarely with comfort.

The sac must not be stripped up if it covers a considerable portion of the bladder. Any attempt to do this will result in haemorrhage or tearing of the organ. Excision should be made around the attachment of the sac to the bladder, going as high as possible on the outer aspect where the sac is free. The bladder is detached gently from its surroundings, in order to avoid tearing, and returned to its normal place.

After the sac has been stripped up for removal, it should be free from any thickening, and should not have any appreciable amount of fat attached to it. It should not be transfixed, ligated or excised until it has been completely detached from all related structures. Often the bladder is wounded because it is not seen.

TYPE I.

The Bladder covered with Peritoneum.

Where there is a large hernia with the larger area of bladder covered by peritoneum, treatment may be straightforward. It may be possible to dissect a sac free and remove it by high ligation. This type of sac may

be direct or indirect. If high ligation is not possible than the condition may be dealt with as indicated below. (Type II).

TYPE II

Partial Investment with Peritoneum.

Here there is a partial peritoneal investment and the condition is almost invariably direct. The sac should be gently separated from the extruded bladder diverticulum and removed. This is frequently difficult owing to the wide base of the sac, and the fact that there is often a flaccid posterior canal wall. These cases can best be dealt with by inserting sutures in such a fashion as to plicate the sac, rolling it upon itself, and thereafter reinforcing the posterior canal wall with fascia or skin. The steps may be indicated as follows:

1. Open the canal by the conventional approach.
2. Retract the cord or round ligament and ensure adequate exposure of the posterior wall.
3. Remove all prevesical fatty or areolar tissue and expose the margin of peritoneum in relation to the exposed bladder.
4. Reflect the sac from the bladder and seize it gently with forceps. Dissect it up to its base and gently retract it outwards to expose fully its length and girth at the base.
5. Where doubt obtains as to presence of omentum or other viscus within the sac, open it and free same.

6. Insert a continuous suture about one quarter of an inch away from the distal extremity of the sac. A second continuous suture is inserted one quarter of an inch proximal to the first, so as to obliterate a further portion. A third row if necessary is applied still more proximally until the sac has been thus obliterated. When the stitches are tied the base of the sac has been stretched tightly over the floor of the canal, and the redundant portion is turned upwards and tucked in by an anchoring stitch to act as a buttress to the area.

7. Fascia transversalis is strengthened by a continuous suture over the whole length of the posterior wall of the canal.

8. Finally, a repair by fascia or skin is performed, and the wound closed in layers.

TYPE III.

The condition is more common with direct herniae. In the rare case where no sac can be located, treatment is far from easy. Any prevesical fat should then be removed, the organ stripped from the adjacent inguinal structures, taking infinite care not to open it, and finally a repair along conventional lines with fascia or skin effected.

Signs of Cystocele at Operation.

During operation, one or more unusual conditions may present, any one of which should arouse suspicion.

(a) The first and most important is the presence of an unusual amount of extraperitoneal fat in the inguinal canal; this should be liberated and not included in the ligature encircling the neck of the sac. Coley, in his unusually large operative experience, by observing this

rule, has never done violence to the bladder.

(b) The hernial opening may be, and usually is, of very large size and out of proportion to the amount of herniated intestine or omentum.

(c) The presenting hernia is most often of the direct type.

(d) Much difficulty may be encountered in separating the hernial sac, more especially the inner posterior portion, from which, if the bladder be involved, free bleeding is likely to ensue.

(e) Identification of the bladder musculature, which, if normal, may readily be done; if thinned out and attenuated as is frequently the case, identification is made difficult and the similarity to that of a hernial sac correspondingly increased.

16.

(f) Where the pedicle does not lead into the peritoneal cavity but behind the pubis.

Accidental Injury to the Bladder.

Where the organ is inadvertently opened the wound should be caught immediately with hemostats and a clamp placed across the opening. Compresses should be placed so that the urine will not contaminate the wound or reach the abdominal cavity. The tear or cut should be closed with interrupted sutures of chromicized catgut in two or three layers; no sutures should go through the mucosa,

which should be inverted in closing. A drain is inserted down to the bladder and allowed to remain for two or three days.

Small Intestine.

Sliding hernia of the small intestine is extremely rare, but has been described. It appears to be associated with some anatomical abnormality affecting the mesentery of the terminal portion so that an area of terminal ileum is deperitonized posteriorly.

In the case described by Williams[13] the affected bowel was devoid of peritoneum over one fourth of its circumference. About six inches of ileum were affected, and the caecum had no mesentery. The peritoneum appears to have reflected abruptly over the terminal ileum and caecum on the ascending colon.

Operation was successfully carried out.

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CHAPTER 20.

HERNIA OF THE UTERUS AND ADNEXAE.

The female internal genital organs may be located within a hernia sac in the following order of frequency, the ovary and tube, the ovary, the nongravid uterus, and rarely the pregnant uterus.

Watson[1.] collected from the literature 219 cases of hernia of the ovary and tube, 181 of the ovary alone, 80 of the tube alone, 61 of the non-pregnant uterus, and 30 of the pregnant. Wakeley[2.] in 1930 reported a series of 25 cases of hernia containing either ovary or tube or both, thus the condition while somewhat uncommon is not excessively rare. Numbers already reported are so numerous that no useful purpose can be gained by exploring the literature in complete detail in order to find out exactly how many in all have been described. Doubtless there have been many examples which have never been reported.

CLASSIFICATION OF THESE HERNIAE.

(1) Inguinal. Most of the reported cases involving the ovary and tube were found in inguinal herniae and then most frequently on the left side. The condition is rarely bilateral, although several have been described.

(2) Femoral. This hernia has been found to contain the ovary or tube on several occasions, and of 156 examples of ovarian hernia collected from the literature, 22 were femoral, while in 68 of the tube alone 20 were femoral.

(3) Other Situations. Camper[3.] and Chenieux[4.] each reported an example of sciatic hernia of the ovarian tube and in the case described by Chenieux there was a large associated ovarian tumour. The condition has also been described in association with obturator hernia, and in 1939, 9 cases had been reported.[1.]

Hernia of the Nongravid tube. This condition has been described in relation to inguinal, femoral and obturator hernia, but most frequently in the inguinal variety.

Hernia of the Gravid Tube. Birmann[5.] in 1922 reported a case of his own and collected 4 others from the literature. Other 6 have been reported since then. This condition may be associated with incarceration.

Hernia of the Uterus. This is most frequently inguinal when non-pregnant, but the pregnant uterus has been described in ventral, umbilical, femoral and inguinal cases.

THE ETIOLOGY. These herniae may be congenital or acquired. Herwig[6.] quoted by Brown, stated that when the Wolffian bodies commenced to atrophy during the 3rd month of foetal life, the ovaries descend from the lumbar region into the

false pelvis, and lie in contact with the psoas muscle. He suggested further, that the ligamentous structure attached to the Wolffian body acts as does the gubernaculum testis on the testicle, with the exception that the descent of the ovaries is not arrested until they reach the true pelvis. It was postulated that the ovaries may comport themselves as do the testicles, and come to lie in the inguinal region opposite the canal of Nuck. At this point they may either enter the inguinal canal or continue to the pelvis, but entry into the canal is favoured by any deformity of the uterus and especially if it is bicornuate.

This suggestion of Herwig has not been criticised in any respect so far as I can see from an exploration of the literature of the subject, but I feel, in view of the fact that hernia of the female internal organs of generation generally occurs in adult life and especially in multiparous women, that the theory is probably not correct.

Watson has stated that the cause of hernia of the ovary and tube is unknown and that the principal factor is probably congenital predisposition. This phrase "congenital predisposition" is so vague in this connection as to be almost meaningless.

Factors which definitely do favour prolapse of these organs into a hernia sac are:

(1) A patent canal of Nuck.

(2) By repeated pregnancies causing divarication of the recti and muscle weakness over the lower abdominal wall.

(3) By relaxation of the parietal peritoneum similar to that which takes place in the sliding hernia of the caecum and where the hernial contents are dragged into the posterior aspect of the sac by means of their normal ligamentous attachments to the parietal peritoneum of the area.

(4) In the presence of a weak abdominal wall with divarication of the recti the pregnant uterus may, by gravity, be located partly within midline incisional or large umbilical herniae.

(5) Deformity of the uterus such as a fibroid, a bicornuate organ or antiflexion, favour entrance of a part of the structure into a patent hernial ring.

(6) An exciting strain, which may be chronic or acute, is necessary in most cases to act as the precipitating factor.

PATHOLOGY OF THE HERNIA CONTENTS.

(1) Ovarian Tube. The ovary and tube are subject to the same diseases as when in their normal situation. Ovarian cysts and tumours may be found and there may be inflammation or abscess within the tube. Tubal pregnancies have been described and there is no reason why ovarian pregnancies should not also be found.

Torsion of the tube and, or, ovary is possible, and may when developed, simulate strangulation.

(2) The Round Ligament. The round ligament has been described in association with strangulation by Dardanelli

and Chevrier.[8] It may act as one mechanism of internal strangulation.

(3) The Uterus. The uterus is rarely normal. In cases described in young people it is often rudimentary and in older women either antiflexed or retroverted. There may be lateral version or a degree of volvulus. The organ itself may show any type of deformity but it is often uni or bicornuate.

Frequently fibromata are described. In the case reported by Royster[9] the patient had a fibroid the size of a billiard ball associated with a uterus which was larger than normal and the tube and ovary with the broad ligament on the left side were all in the sac. In addition there was a complete absence of the right tube, ovary, and broad ligaments.

Any other diseases which may normally affect the uterus may be associated with the herniated organ.

(4) Trauma to Contents of Sac. The ovary and uterus when herniated are liable to trauma and to interference with the circulation. The ovary especially may become inflamed and simulate strangulation. Recurring sub-acute trauma may lead to atrophy of the ovary but a premature menopause will not be found so long as the other organ is functioning.

PREGNANCY IN THE HERNIATED UTERUS. Farrar[10] reported a case of hernia of the uterus with both adnexae into the inguinal canal and also an example where pregnancy carried on to term within a hernia sac. Delivery was effected by section and a live child obtained although the mother perished.

Where the pregnant uterus is associated with a large umbilical or sub-umbilical midline incisional hernia pregnancy may go on to term and normal delivery be conducted. In other situations if the uterus can not be reduced to its normal situation the pregnancy should be terminated at an early date.

Symptoms and Diagnosis. Where only the ovary and tube are involved symptoms are mainly confined to the ovary and depend in part upon the age of the subject. In infants and young children the organ is palpable within the sac as a mobile, hard, ovoid swelling approximately the size of a large pea. It may be irreducible, lying in the labium majus or just medial to the internal ring. It is sometimes associated with omentum or intestine. In young patients, pain may not at first be a conspicuous complaint contrasting with the findings in the adult.

In the adult the herniated ovary is often hyper sensitive and varies in size with the menses. Swelling and pain are generally most pronounced during these times.

Hernia of the tube alone may be symptomless, excepting where the tube is abnormal, or, when it exerts traction on either ovary or uterus.

The herniated uterus can often be recognised by palpation and may vary in size with the menses. Diagnosis by vaginal examination is usually possible.[11.] Lassus was the first to point out that the uterus on vaginal examination is often displaced to the same side as the hernia.

COMPLICATIONS. The most frequent complications are torsion or strangulation of the adnexae, and infection of the sac from an infected tube.

If the tube or ovary forming part of the pedicle are twisted, a tender swollen and irreducible swelling is found over the hernia site and if the torsion is sufficiently severe strangulation may set in. This is associated with redness and swelling of the major labium on the affected side, plus all the classical general signs and symptoms of strangulated hernia.

Strangulation has been reported at all ages and in association with both inguinal and femoral cases.[12.] Muller reported a case of acute strangulation of the ovary and tube in a child aged 2½ months and removed the diseased organs on the left side. A few weeks later the swelling developed on the right side which was operated on by Muller when the child was 5 months old, and an ovary and

tube again located within the sac. These were restored to the abdominal cavity and the hernia repaired. Delepine[13.] reported a case of strangulated femoral hernia involving the fimbriated end of a tube and reviewed all the published cases at that time. He stated that diagnosis had never been made before operation.

The cause of strangulation is almost always torsion of the pedicle and not constriction by the hernia ring. If the ring is the mechanism there may be superadded symptoms and signs, and especially when other viscera, for example omentum or intestine, are also present.

THE DIFFERENTIAL DIAGNOSIS. Cysts and tumours of the canal of Nuck may cause confusion. Cysts are translucent to light, irreducible, demonstrate fluctuation and generally painless. Tumours are rare. It is not possible clinically to diagnose a tumour within the female inguinal canal with assurance. One can only recognise a firm fixed and irreducible swelling.

If other viscera are present in association with the special organs under consideration a definite diagnosis is impossible unless the intestine or omentum can be reduced and the ovary or uterus identified by palpation, vaginal and bimanual examination.

PROGNOSIS. The presence of the uterus within a sac is potentially dangerous to the woman concerned. Pregnancy is

possible and may be fatal to the mother, excepting in the special incisional and umbilical cases where there is a large sac and neck.

It has been stated that a herniated uterus is more liable to undergo malignant change than is the normal organ.

These herniae are otherwise less dangerous than other cases.

TREATMENT. These cases should be treated along conventional lines, the sac opened in the usual way and the contents returned to their normal position wherever possible. Lussana[14] has warned against resecting the herniated organs if they appear sound.

HERNIA OF THE UTERUS AND ADNEXAE IN THE MALE.

Braithwait and Craig[15] reported the findings of an operation performed for a left sided scrotal hernia in a boy of 14. The boy appeared to be quite normal and the perineum was not dimpled. The right side, however, had an undescended testis. A conventional incision was made and the sac exposed. The sac and testis were withdrawn into the wound and the sac opened to expose a perfectly formed Fallopian tube which had no direct connection with the testis. Traction upon the testis and tube brought into view the whole of the internal organs of generation of a female. The uterus was the normal size for a girl of

14. It was bicornuate and entered, at the cervix, a structure composed of fibrous tissue which extended down in the normal position of the vagina as far as the perineum. This vagina was not hollow. On either side of the uterus there was a perfectly formed Fallopian tube. The undescended testis was attached to the broad ligament by a mesentery and had no epididymis or vas deferens. The whole block of organs was remarkably mobile and they could easily have been excised but were left in situ. The boy made a good recovery.

16. Clarke reported a similar case where the external appearances were those of a normal male and yet a hernia sac contained the uterus, broad ligaments, and Fallopian tubes.

Other similar examples have been described, and in the museum of St. Bartholomew's Hospital there is a specimen removed from a man aged 44, where a uterus, almost the size of an adult female lay between the bladder and rectum. It was enclosed between two layers of peritoneum, to which, on either side the testes were attached.

At a meeting of the British Medical Association in London in 1895 the internal organs of a child who died after operation for inguinal hernia, were shown. There was a normal bladder with prostate gland. Projecting backwards from it were a vagina, uterus, broad ligaments, round

ligaments and Fallopian tubes with the testes occupying the place of ovaries.

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CHAPTER 21.

LITTRE'S AND RICHTER'S HERNIA.

DEFINITION.

(a) Richter's Hernia. This is a partial enterocele, only a portion of the intestinal wall and its lumen being nipped within a hernia ring. It has also been termed masked hernia, nipped hernia, and Lavater's hernia.

(b) Littre's Hernia. This is a hernia of a Meckel's diverticulum.

These two conditions are considered together because they have sometimes been confused, and because of the similarity of their symptoms. Richter whose name has been given to the type known as a partial enterocele described 2 cases, but they seem in fact, to have been hernias of a Meckel's diverticulum.[1,2.]

ETIOLOGY.

(a) Richter's Hernia. The etiology of this hernia is obscure but it has been described in association with femoral, inguinal, obturator, umbilical, ventral and sciatic cases. It is most probable due primarily to adhesion between intestine and parietal peritoneum immediately overlying the neck and mouth of a hernial sac. Under these circumstances sudden increase in intra-abdominal pressure or irregular peristalsis of the bowel may insinuate

a portion of the wall into the mouth of a sac. For this to take place it is necessary that the mouth be patent and the muscular structures relating to it, if any, relaxed. It would be impossible, in the absence of muscular relaxation, for such a strain to force an entry of bowel into a closed hernial ring.

(b) Littre's Hernia. Forgue and Riche[3.] collected 600 cases of Meckel's diverticulum from the literature and in 52 of these there was an associated hernia.

The cause of the hernia is uncertain but it may probably develop by the same means as a Richter's or any other ordinary type. It is most frequent in middle aged patients and there is a preponderance in males.

SYMPTOMS AND SIGNS.

(a) Richter's Hernia. The symptoms of early partial enterocele are lacking in any characteristics enabling diagnosis to be made. Strangulation takes place early and is characterised by the fact that constipation is not absolute, and vomiting may be, and usually is, absent. If vomiting develops it rarely becomes faecal. This hernia is potentially more dangerous than others because of the absence of an obvious swelling on examination, or definite history of previous hernia. The patient is usually found with the symptoms and signs of an acute abdominal catastrophy and diagnosis is rarely easy. There

is often tenderness on examination of the hernial rings over the affected site and, in strangulation, there may be some local signs of inflammation.

Diagnosis is generally made only at operation.

(b) Littre's Hernia. This hernia also presents no characteristics upon which the diagnosis can be made. It is not even possible to diagnose the presence of a Meckel's diverticulum itself. The condition closely resembles that of partial enterocele, hernia of the appendix vermiformis or inflammation of herniated appendices epiploicae.

In the series collected by Forgue and Riche the diverticulum varied in its appearances, being either closed or open, inflamed or strangulated. In some there were associated simple tumours and in others intestinal cysts. The condition is peculiarly liable to recurrent attacks of inflammation with subsequent development of adhesions leading to irreducibility.

In thin patients it may be possible to suspect the presence of a Meckel's diverticulum where the contents of the sac are intestine which appears to terminate in a blind end and not as a loop. This possibility, however, is unlikely to be of value in diagnosis.

When the diverticulum is inflamed the symptoms and signs resemble hernia of an inflamed appendix but they are less severe owing to the larger calibre of the Meckel's

diverticulum.

In practice the lesion is rarely recognised before operation.

COMPLICATIONS.

(a) Richter's Hernia. The characteristic complication is strangulation. Here the constricted portion of gut wall becomes distended, and may at operation simulate a short Meckel's diverticulum. Gangrene occurs early. Roser[4] in 1886 disputed the right of this condition to be classified as a hernia, because the mesentery of the bowel did not enter the sac, and he further denied the existance of partial strangulation of the bowel. Whether or not the condition is technically a hernia does not alter the fact that strangulation in varying degree can and does take place.

(b) Littre's Hernia. The diverticulum is subject to all the changes which may affect the structure in its normal position. Ulcers, tumours and cysts have all been described. The characteristic complication is strangulation which may go on to abscess and fistula formation. Examples of this have been reported by Owen[5], Arnison[6], von Kliegl[7] and Bowlby[8].

PROGNOSIS.

(a) Richter's Hernia. The prognosis is grave if strangulation is not early recognised. 53 cases were

analysed by the late Sir Frederick Treves[9] of which 50% were not diagnosed or subjected to operation. They all died. Fraser[10] has also indicated the difficulty of diagnosis in these cases and the relation of this difficulty to prognosis.

(b) Littre's Hernia. The outlook here is more favourable than in other cases, as the main lumen of the bowel is not interfered with in any complication, and is sufficiently wide to permit drainage of the products of inflammation into the ileum. The prognosis is more favourable, even in strangulation.

Metcalf[11] delayed operation in his case for a day. The prognosis becomes more grave with such time loss.

TREATMENT.

(a) Richter's Hernia. This condition has probably never been operated on primarily by election after diagnosis has been made in the absence of complications.

In strangulation or inflammation the treatment consists in operation with removal of the sac and disposal of the diseased portion of bowel. The principles followed in this connection are similar to those already described in Chapter 3. The area of intestinal wall affected may be viable or non-viable. If small it can be invaginated with a purse-string suture. On rare occasions excision of the small portion of bowel may be necessary.

(b) Littre's Hernia. The treatment follows the conventional lines. An incision is made to expose the sac and the contents are reduced if possible. In an uncomplicated case where a Meckel's diverticulum is recognised during a hernia operation, it should be excised at its base flush with the intestine wall. The area is then carefully oversewn. A pad of omentum may be made to overlie the suture line.

In strangulation the same principles are followed as have already been described and excision of the diverticulum is carried out whenever possible.

CONJOINED LITTRE'S AND RICHTER'S HERNIA.

Sinclair[12] is amongst those who have reported an example of these two rare types of herniae coexisting in the same patient. His case was located within a single femoral sac.

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CHAPTER 22.

HERNIA OF THE VERMIFORM APPENDIX.

Incidence. Hernia of the appendix is not common and is more frequent in adults during late middle age. The appendix is rarely present alone in the sac and is generally accompanied by omentum, caecum or small intestine.

The condition was first described by Garengeot[1.] and later by Sandifort[2.], Tritschler[3.] and Rust. Other early contributions were by Bajardi[4.] and Brieger[5.].

In a series of 250 cases of radical cure for hernia by the Bassini method reported by Hoffman[2.] from the Albert Clinic Vienna, the appendix was found in the sac 9 times, and of 106 Bassini operations reported by Wassiljew[6.] it was present in 3. Bundschuh[7.] met with the appendix three times in 109 consecutive operations for strangulated femoral hernia. In my own series of 454 cases of inguinal hernia the appendix was present in the sac only in 2.

Wood[2.] has stated that the relative frequency of pure appendicular inguinal and femoral hernias might be expected to preserve about the same ratio as that which exists between the usual forms of these two varieties, and in Brieger's series and in those of Bajardi and also in a series of 145 analysed by Spurrier and Corner[8.] the higher proportion were inguinal. In a series of 63 caecal

hernias analysed by Gibbon[9], 56 were inguinal and 7 femoral. The appendix was present in 7 femoral cases, but absent in 15 of the inguinal.

An analysis of published cases by these authors indicates that the ratio of femoral to inguinal cases is as one to eight, and of solitary appendicular hernia, as one is to three.

Gibbon[9] has collected the combined experience of Coley and Halsted in a total of 642 herniotomies in which the caecum or appendix was found in the sac 21 times. In only 3 of these was the patient over 15 years of age. But of this series 16 were reported by Coley whose work was chiefly among children. Of the total numbers analysed by myself from the literature, approximately 60% took place under the age of 40.

ANATOMY.

The appendix in these cases is generally situated originally in closer relationship than usual to a hernia ring and the caecum and appendix are mobile.

The appendix may be alone in the sac or accompanied by viscera commonly the caecum or omentum.

ETIOLOGY.

The condition may be congenital or acquired and it has been described at birth.

Certain anatomical facts predispose to the

development of the condition. These are a mobile caecum, the presence of a mesentery to the caecum, a long appendix and ptosis of either organ. In sliding hernia the caecum may pull the appendix into the sac and in omental hernia if there are adhesions between the omentum and the appendix, the latter organ may also be drawn down into the sac.

CLASSIFICATION.

(1) Inguinal. This is the most common type and comprises approximately 60% of the recorded cases. The reason for this is probably in part due to the relationship between the appendix and the internal ring, and the fact that the inguinal ring is larger than the femoral.

(2) Femoral. This is most frequently found in women and constitutes about 40% of all cases. 10.

(3) Ventral. Ventral hernia of the appendix may be found in small cases in relation to an incisional hernia developing after appendix abscess. It is otherwise rare.

(4) Umbilical. Umbilical hernia containing the appendix alone has not been described so far as I can ascertain from an exhaustive survey of the literature. It is, however, found in large umbilical hernias containing the caecum or terminal ileum.

(5) Other Situations. The appendix has been described in association with diaphragmatic hernia, but always when accompanied by other organs. Watson 10. described two cases of isolated appendicular obturator hernia.

SYMPTOMS AND SIGNS.

The organ may be palpated within the sac in young children and in persons of spare build. In the series reported by Wood a firm mass was present within the sac in each instance. There is considerable pain and abdominal discomfort.

The symptoms are frequently those of complications and especially is this so when the appendix is inflamed. This is described in a later paragraph.

In femoral cases the pain may be referred to the hip joint and down the medial aspect of the thigh so far as the knee. Even in sub-acute inflammation, movement of the thigh on the affected side is limited and generally associated with local pain which may be referred also to the right iliac fossa.

If the appendix is present alone in the sac and reducible it does so without any gurgling and there is no impulse on coughing.

INFLAMMATION OF THE APPENDIX WITHIN A HERNIAL SAC.

This condition varies somewhat from the characteristic clinical picture presented by the usual forms of acute appendicitis. There may be a preliminary stage of peri-umbilical colic followed by pain referred to the scrotum. There is usually no rigidity of the abdominal muscles and less general disturbance. Pain referred to

the thigh or hip joint is frequent and aggravated by movement. Locally the condition is tender on palpation, usually irreducible and there may be overlying redness and swelling of the skin suggestive of local strangulation.

Distention of the abdomen is frequent for a reason which is obscure, there is usually no constipation and flatus is freely passed.

The condition is ushered in by an acute onset, but the temperature is rarely so elevated as in abdominal appendicitis.

Abscess formation may take place as in any other form of appendicitis. This may rupture through the sac but the patient usually comes to operation before then.

There may at this stage be disturbances of micturition, with frequency and dysuria. These phenomena may also be present during the earlier stages of the disease.

STRANGULATION OF THE APPENDIX.

The appendix is supplied by a single artery which, with its veins, is liable to pressure from the hernia ring, from kinking of the organ, from torsion and from traction. This predisposes to strangulation which may take place at an early stage in the disease. Partial strangulation with thrombosis of the blood vessels and haemorrhages into and around the mesoappendix has been

described by Pascal and Pilliet, by whom the term apoplexy

of the appendix was given to describe the condition.

COMPLICATIONS.

A non-inflamed organ may become curled or kinked upon itself and its lumen be obstructed. This may cause a cystic distension due to the continued secretion from Lieberkuhn's follicles. This may simulate a cyst of the small intestine or Meckel's diverticulum.

The other complications which are most common have already been indicated, and are strangulation, inflammation and incarceration. Retrograde strangulation may be found where the organ is long and attenuated, but is very rare and according to Gray[12.] ordinary strangulation is twice as frequent as inflammation.

It is of importance to note that occasionally strangulation of the appendix may give rise to nausea, vomiting which may be faecal, absolute constipation and abdominal distension. This is uncommon, and due to reflex inhibition of the intestinal tract, but not to organic obstruction.

DIFFERENTIAL DIAGNOSIS.

An irreducible omental hernia presents a hard irregular mass which may be confused on palpation with the appendix. It is insensitive to pressure unless inflamed.

A Richter's hernia causes symptoms of strangulation in the absence of intestinal obstruction, and may therefore,

be confused with strangulated or inflamed hernia of the appendix. The differential diagnosis is not easy, but, in the partial enterocele, vomiting and shock are more obvious and general symptoms more severe.

Torsion or strangulation of the ovary or tube within a hernia may be difficult to distinguish from inflamed or strangulated appendicular hernia. The ovary and tube may be moved with the uterus on vaginal examination. Strangulation of an epiploic appendix may closely simulate this complication of the vermiform appendix, but is generally located on the left side.

Other conditions which must be considered are torsion of the spermatic cord or undescended testis, hernia of a bladder diverticulum and inflamed femoral lymphatic glands.

PROGNOSIS.

In the series reported by Wood, 3 died out of 52 in which the appendix was removed, and in 17 the appendix was reduced but not removed and with one death.

REMOVAL OF THE NORMAL APPENDIX DURING HERNIA OPERATIONS.

It is a common practice to remove the appendix through the opened sac during operations for inguinal hernia. I have seen the results of this procedure in many Service cases dealt with by other people during the last 5 years. I am unable to give exact figures for the incidence of complications after this operation as the men generally

passed through my hands for only a short time, but in Oldmill Hospital many convoys varying in size from dozens to hundreds have been admitted throughout the present war and substantial numbers of men had been subjected to inguinal hernia operations combined with removal of the appendix. The results were almost uniformly bad and the majority, a great majority, showed wound sepsis and an early convalescence complicated by chest troubles or irregular pyrexia.

Contrasting with these were the hernia cases admitted from other hospitals and hospital ships, where the appendix had not been removed. These results were satisfactory and the difference between the two was striking.

From the point of view of technical difficulty I am of the opinion that no appendix can be removed through an inguinal hernia sac unless the internal ring is very considerably dilated and in the absence of adhesions around the appendix. Moreover, any attempt to remove the appendix by this route may further dilate the internal ring and render it more than usually incompetent. Finally, I am of the opinion that as a general surgical principle any operation should be performed for the cure of a particular condition and that it is not sound practice to increase the scope of that procedure beyond what is necessary to achieve an effective cure.

In my view there is nothing to commend the routine removal of the non-inflamed appendix through a hernia sac with the possible exceptions of large ventral and umbilical cases. Even there, it can be criticised on the grounds that such patients are generally not good surgical risks and that the operating time should there be cut down to a minimum.

TREATMENT.

The condition should be treated along lines commonly followed in any hernia. If at operation the appendix is found either with the caecum or alone within the sac but the base easily and clearly identifiable, the organ may be removed. Where it has been the seat of attacks of inflammation and at operation is within the sac, then again it should be removed. A conventional repair should complete the operation. In a proportion of cases, the problem of a sliding caecal hernia will require consideration.

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CHAPTER 23.

SUMMARY AND CONCLUSIONS.

The work may be summarised as follows:

1. A history of the treatment of hernia throughout the centuries has been outlined, and special emphasis given to those methods evolved during the past fifty years.
2. The subject has been approached first by a full discussion of the anatomy and physiology of the anterior abdominal wall and hernial and other orifices under consideration. The significance of each relevant structure, functionally and anatomically is considered from the point of view of etiology, progress, pathology and treatment of inguinal, femoral, umbilical, epigastric and ventral hernia.

The most important anatomical facts are shown to be:

(a) The anomalies which may relate to the processus vaginalis.
(b) Abnormalities of testicular descent with consequent effects upon the anatomy of the inguinal canal.
(c) The variations in insertion of the conjoined tendon into the pubis and rectus sheath. These may result in an area of the posterior wall of the inguinal canal being bereft of support from the conjoined tendon medially, the structure inserting into the lateral margin of the rectus sheath up to one inch or more above the pubis. In addition, it has been shown that the conjoined tendon may be a flimsy structure and of little value as a means of support even when its insertion is normal.

These two facts together are considered to prejudice the success of any operation in which the structure is utilised as a means of repair. In the first case it is not possible to effect firm union to Poupart's ligament, and in the second, the structure is so attenuated that even when used it is of little assistance in preventing recurrence.

(d) The distribution of the ilio-inguinal and ilio-hypogastric nerves is considered, and it is shown that the sections exposed during herniotomy are purely sensory in function. It is also suggested that nipping of either of these sensory nerves in a suture may be a potent source of post operative pain referred to the wound area.
Section of motor fibres by an incision at a higher level, as for example, in a grid iron appendix incision, may lead to muscle atrophy of those fibres of internal oblique innervated by the nerves, and predispose to development of inguinal hernia at a later date.

(e) The function of the conjoined tendon and the sphincteric action of the muscle fibres of the internal ring are considered. It is suggested that this mechanism is of high importance in preventing the extrusion of an organ into a congenital sac, and secondly in preventing the development of the so-called acquired type of sac.
The mechanism whereby the sphincteric actions of these structures may be overcome and lead to hernial formation is discussed. It is shown that repeated minor traumata are of importance in this regard, and that especially when the thighs are flexed, relaxing the posterior wall of the canal.

(f) The effect of the presence of the deep epigastric vessels is considered and it is shown that they do have some function of support to a small area of the posterior wall of the canal. Their classical significance in dividing anatomically the direct from the indirect type of hernia is mentioned.

(g) The relation of the muscles involved in the formation of the inguinal canal, to the function of respiration is considered. The effects of increased intra-abdominal pressure, sudden and prolonged are analysed, and the relationship of these muscle groups to the 'inguinal sphincters' analysed.

(h) The importance of the fascial layers, especially the fascia transversalis, is demonstrated to be high. These fascial layers are viewed anatomically, and from a point of view of operative treatment.
(i) The rigid nature of the femoral ring and anatomy of the canal is considered to favour formation of hernia.
(j) The importance of the linea alba as a support from which the powerful antero lateral muscles of the abdomen may act is emphasised as of importance in the prevention of divarication of the recti, in the repair of umbilical hernia, in relation to mid line incisional hernia and to the cure of incisional hernia.
(k) The umbilicus is considered in detail and with special regard to the support given to it by foetal remnants attaching to it and giving especially strong support from below.

3. The etiology of inguinal hernia, both direct and indirect, is considered in the light of the above information, and it is shown that the practical treatment of hernia depends largely on the view adopted in regard to etiology.

The preformed sac theory, of Mr. Russel, is discussed and it is believed to be applicable to a very large number of indirect cases. It is suggested, however, that there remain other groups of indirect herniae which are not explicable on the Russel Premise. The possibility of acquired hernia being found is accepted.

The congenital sac theory is also considered in relation to femoral and umbilical hernia.

4. There follows a discussion on the anatomy of the hernial

sac, with reference to the classification of inguinal hernia on an anatomical basis. Other classifications based on the clinical findings are indicated.

5. The clinical condition and progress of both indirect and direct inguinal herniae are outlined, and complications, with etiology and treatment considered.

6. The treatment of herniae is discussed in detail. It is shown that:

   (a) The Bassini Operation with all its modifications is unsound. The results of treatment, the rationale of the procedures, the recurrence figures and the reasons for recurrence are all considered. The operations are shown to be wanting because:

      (1) They all have one feature in common, namely an attempt to unite the conjoined tendon with Poupart's ligament. A mass of evidence has been adduced to indicate that whilst such a union may take place, it does so only under certain specific conditions, and even then only by means of weak scar tissue which is liable to stretch and predispose to recurrence.
      (2) The conjoined tendon is anatomically frequently not sufficiently powerful to be of value as a method of support. The larger the hernia the more likely is conjoined tendon to be atrophied. Even when it is used there frequently remains a potentially weak area immediately lateral to the pubic spine which is liable to be the seat of recurrence.
      (3) Emphasis has so often been laid upon the union between conjoined tendon and inguinal ligament that the importance of buttressing the fascia transversalis and narrowing the pillars of the internal ring, has often been lost sight of, though described originally by Bassini. These steps must be performed as a preliminary to all types of repair.
      (4) The final analysis of evidence based on late results is not encouraging. This is confirmed by the fact that so many surgeons have found it

necessary to modify the original operation.
This is suggestive of their having found it wanting.
The recurrence rate is too high.

(b) The Bassini Operations having been demonstrated lacking in success, alternative methods are considered.

(1) It is shown that the best method of treatment for all cases where the integrity of the canal has not been destroyed and where muscle tone is sound, is simply high excision of the sac, combined in most cases with a line of stitches buttressing the posterior wall of the canal and applied only to the fascia transversalis.

(2) Where need for repair arises the use of fascia is considered.
Fascia has certain disadvantages and these are outlined. It is nevertheless, admitted that fascial sutures give better results where a repair is indicated than do the Bassini Operations.
The development of the technique, the histology of the fascia and description of its use is appended.

(3) The little considered method of Cutis Graft Repair is described, and the known information relating to this method compiled and reviewed. The cutis method is shown to be sound, but to possess one or two minor disadvantages. It is considered to be an advance on fascia.
The clinical results of the method are laid forth, but these are so scanty that definite conclusions can not so far be formed.

7. The use of whole skin grafts as a substitute for cutis in the repair of herniae is described, and the results of investigations into the histology of the grafts detailed. It is shown that when whole thickness skin is sutured under tension to fascial or aponeurotic structures, that a translation of the skin into vascular fibrous tissue takes place. This is

associated with loss of all identifiable characteristics of skin, and the graft closely resembles, within a few months, the structure to which it has been sutured, that is, fibrous tissue.

The sequence of events during this translation of whole skin to fibrous tissue are described in detail and illustrated.

Microphotographs and descriptions of these changes as found in rabbits are inserted, and two examples in the human subject. Dangers of epidermoid or inclusion cyst formation are discussed, and at this point there is a digression to consider under what circumstances these cysts may be found.

The final evidence is in favour of the safety of the procedure. There has been no suggestion during the work that when the graft is inlaid under tension any risk of later cyst formation exists.

The application of this principle to the treatment of herniae is outlined, and a detailed description of the method as applied to repair of inguinal hernia given. This is richly illustrated with photographs taken during operation. A photograph of a graft three months after implantation is given to illustrate the gross alteration in its appearances. The results of 149 cases treated by this technique, and full survey of all post operative

complications, immediate and remote are described. These are compared with a series of 120 fascial repairs, 88 Bassinis, and 94 simple herniotomies performed in Woodend and Oldmill Hospitals, Aberdeen by myself. The superiority of the method is obvious with the material available to date.

The cases have been followed up for a maximum period of twenty two months. Recurrence for the whole skin graft series is 1.1% and this figure is reached only after each case had been re-examined by a colleague as well as myself. No doubtful case has been accepted as cured. Criteria of recurrence and factors influencing decision one way or another have been outlined.

On the evidence to date it is suggested that there is encouragement to use the method more extensively, and to compile larger numbers of cases for analysis. In my hands with the available series of cases, and present evidence, the suggestion is that the method holds promise of success.

8. Certain factors in operative treatment are analysed, and it is suggested that the optimum anaesthetic is nitrous oxide, oxygen and ether, in order to effect full muscular relaxation, a factor essential to the efficient inlaying of the graft. Experience in Aberdeen would tend to support the use of absorbable chromicised cat

gut in preference to non-absorbable sutures, for anchoring the graft, and finally the importance of fixing it under maximum tension along the posterior wall of the inguinal canal is emphasised. The graft when properly disposed, overlaps the pubis medially, is anchored superiorly to the aponeurotic medial expansion of the internal oblique, and inferiorly to the shelfing edge of Poupart's ligament. Laterally it is split to enclose the cord and form a skin ring over the internal ring, the skin being sutured lateral to the internal ring.

In my own experience it has been found that the operation is technically more difficult to perform than a fascial herniography and that at first it requires some fifty minutes operating time. With a little experience, this has been cut down to less than half an hour for the average case.

9. Umbilical, femoral, ventral and epigastric herniae are each considered under the same headings as already described for inguinal. It is shown that the skin method of repair is applicable to each, and it is especially advised as a final stage in the Mayo repair of umbilical cases, and after formal repair of ventral cases. It is also applicable to any femoral hernia requiring more than simple excision of the sac.

10. In conclusion of the text matter there are notes on unusual herniae, Richter's and Littre's herniae, herniae of the uterus and adnexae and appendix.

11. Appended are notes on all the cases of the series under discussion, and short description of the various modifications of the Bassini Operation.

As a result of this work, the following conclusions have been made:

1. That in the treatment of inguinal herniae there is reason to revise radically, current and formerly accepted views on the efficiency of all the Bassini types of operation.

2. That in place of these operations, where there is indication for a plastic method of repair, fascia or whole skin should be used in all cases.

3. That upon consideration of the evidence to date, the whole skin graft is superior to fascia for this purpose.

4. That the whole skin method is safe, efficient, based upon sound principles, and so far associated with a satisfactory recurrence rate.

5. That the whole skin method is associated with a low immediate, and remote post operative morbidity rate.

6. For those cases where the muscles of the canal are sound and the canal not stretched, no repair should be

performed, and the essential of treatment is then high removal of the sac. This is the essential step also of all cases which do require repair.

Results show that in small herniae, best results are achieved by conservative treatment. In the surgery of inguinal hernia, as in all other types of surgery judgment and conservatism - compatible with the attainment of an end - are the keys to success.

12. The problems of cure in femoral, ventral, epigastric and umbilical hernia are considered and the skin graft technique demonstrated to be capable of use in each of these cases. It is emphasised in the case of femoral hernia, that small swellings may need only a conservative operation of herniotomy. Where a plastic repair is required the Skin Graft Technique is shown to be particularly suitable for large cases of all types. It is not suggested that it is superior to fascia in the repair of femoral hernia, but it is claimed that the evidence to date suggests that it is suitable and may prove to be at least as good.

13. The excellence of the Skin Graft method in umbilical and ventral herniae is demonstrated. It is, in these cases, used to reinforce a conventional repair.

14. The problems of sliding and extra saccular hernia are considered, especially from the point of view of etiology.

15. Finally there are observations on herniae of special organs, and the special types known as Littre's and Richter's.

The main object of this thesis has been to seek, without bias, the truth concerning many problems offered by these herniae and to produce order out of chaos in the treatment of the conditions.

Simplicity combined with efficiency is the keynote to success in surgery. Few surgical conditions have become so surrounded by passionate views and controversy as have herniae. Truth has tended to become hidden in a welter of dogmatic observations, thousands of pages of writing, and didactic teaching.

This work has been performed dispassionately and a considerable effort made to sift accuracy and truth from these many writings. I will be well satisfied if that alone proves of value. The future of the Skin Graft Method depends on the passage of much more time and the collection of many more observations on its merits and faults.

APPENDIX 1.

THE BASSINI OPERATION and its MODIFICATIONS.
BRIEF OUTLINE of the FUNDAMENTAL STAGES of EACH.

Marcy (1881).

The essential steps of this operation were high ligation of the sac and transplantation of the cord with a repair of the canal. Conjoined tendon was sutured to Poupart's ligament with interrupted stitches of kangaroo tendon.

It is seen that this is fundamentally similar to a repair with fascial strips inserted after the fashion of Bassini. It is a good method and, in my view superior to that of Bassini. Further, it was described at an earlier date, and one wonders why the honour for designing a firm repair was not given to Marcy rather than to the Italian.

MacEwan (1886).

In this repair the sac was freed to a point one inch beyond the internal ring, and then folded into a pad which was sutured into the ring. Sutures were brought through the muscles above the ring and then through the skin over which they were tied. MacEwan customarily left a small drain in situ.

Traces of this operation are shown in the step common

to many surgeons, of fixing the transfixed stump of sac to the muscles of the anterior abdominal wall above the ring.

The MacEwan operation has largely fallen into abeyance generally but some of his former students still claim good results with it, and it has by some been combined with a Bassini.

Halsted (1889).

Repair was made by sutures passed through the internal oblique and conjoined tendon, to pick up the cremaster muscle and return through the internal oblique and conjoined tendon so that the cremaster muscle and fascia is drawn up under the internal oblique and conjoined tendon. The cord is left undisturbed and further repair effected by suturing the internal oblique and conjoined tendon anterior to the cord to the shelving edge of Poupart's ligament. Finally the upper flap of the external oblique is sutured to the anterior surface of the internal and conjoined tendon, and the lower flap to the anterior surface of the upper.

This operation is clumsy, and less mechanically effective than the Bassini. It was later modified in several respects by the designer, suggesting that he was alive to its deficiencies. Finally it closely approximated to that of Bassini. It is rarely, if ever, performed now according to the original description.

The Classical Bassini Operation (1889).

The aim of the operation is to reinforce the posterior wall of the inguinal canal by uniting the conjoined tendon and lower margin of the internal oblique muscle to the shelving edge of Poupart's ligament.

The canal is opened through the conventional approach, and the spermatic cord lifted out. Sutures are inserted through both conjoined tendon and fascia transversalis on the one hand, and Poupart's ligament on the other. These are carried up to the internal ring from the medial extremity of the canal. Usually they are interrupted, but occasionally a continuous mattress has been employed.

The cord is permitted to drop back into its bed and the cut external oblique aponeurosis repaired.

In this operation, as in all others to be described, the sac of the hernia is removed before performing the repair. That step performed, the incision through the coverings of the cord is repaired by a fine running suture of four o cat gut. The skin is closed by interrupted stitches or clips.

The Wyllis Andrew Modification (1895).

Conjoined tendon is sutured to Poupart's ligament as in a conventional Bassini repair, but, thereafter the upper cut flap of the external oblique aponeurosis is

sutured to the shelving margin of the inguinal ligament BEHIND the cord. The lower flap is sutured to the surface of the external oblique aponeurosis over the cord and anterior to it.

This modification gives one extra layer of fascia posterior to the cord, but has the disadvantage that compression of the cord is possible, and even probable.

Fowler (1897).

After ligation and removal of the sac, the deep epigastric artery is divided between ligatures. The fascia transversalis and peritoneum are then opened and the cord inlaid into the peritoneal cavity, but made to emerge again at the lower end of the incision which is closed over the cord from lateral to medial. The canal is then completely closed by union between the conjoined tendon and Poupart's ligament anterior to the cord.

This operation removes the weak spot of the area to the medial end of the canal which remains largely unprotected. Any recurrence is similar to the direct type.

This operation has not found general favour, and is now rarely performed.

Bloodgood (1898).

Bloodgood used a flap of the rectus sheath and muscle, transplanted to reinforce the posterior wall of the

canal. The transplant was drawn down and sutured to the shelving edge of the inguinal ligament in company with the internal oblique and conjoined tendon.

This operation, modified to some extent, is still commonly used and the rectus sheath transplant is, in effect, a fascial transplant. As such it is useful enough, but rectus muscle should not be included in it, nor should the conjoined tendon be united with Poupart's ligament.

Brenner (1898).

This operation is essentially a Classical Bassini, combined with a step which unites the cremaster muscle to reinforce the union between conjoined tendon and Poupart's ligament.

Fergusson (1899).

The external oblique aponeurosis is widely separated from that of the internal to expose the internal ring. This is then narrowed without disturbance of the cord, and finally the flaps of the external oblique are overlapped in front of the cord.

Scott (1905)

This is similar to a Classical Bassini in its early stages. After powerfully stretching the conjoined tendon,

and uniting it with Poupart's ligament a relaxing incision is made along the outer border of the rectus sheath.

The external ring is obliterated, and the cord made to emerge through the external oblique aponeurosis about half way along the line of suture, that is the external ring is really removed lateral to its original site.

This operation has several technical disadvantages. First the sutures must be inserted under a degree of tension which imposes a considerable strain on both ligament and muscle, possibly tearing both, and certainly causing a necrosis of muscle fibres. Secondly there is a definite risk of occluding the cord at the site of emergence through the external aponeurosis.

Torek (1906).

This operation is similar to that of a Classical Bassini, save that all structures are separated from the cord excepting the vas and essential vessels.

This stripping of the cord is associated with a definite element of risk, both to the vas and to the testicular and spermatic arteries.

After separation of the elements, repair by the Bassini method is adopted, but the structures utilised in repair are made to lie between the veins and fascia on the one hand, and vas and vessels on the other so that the

former lie superficial and later.

McGavin (1909).

The sac is removed by high ligation and the deep epigastric artery severed between ligatures.

A silver filigree plaque is then placed on the posterior wall of the inguinal canal and retained in position by suturing the conjoined tendon to Poupart's ligament.

This is really a combination of the filigree repair with a Bassini, showing that the author had confidence in neither. The operation is associated with the risks of the filigree implant and the defects of the Bassini. Little can be said in its favour.

Downes (1911).

The sac is removed and a running buttress stitch applied to strengthen the fascia transversalis.

The rectus sheath is then incised to expose the muscle so far as its insertion to the pubis. The edge of the rectus sheath is then united to the shelving edge of Poupart's ligament, and the internal oblique similarly dealt with under the cord.

OTHER OPERATIONS FOR INGUINAL HERNIA.

McArthur (1904).

This is fundamentally a Bassini repair, excepting that strips of fascia cut from the upper and lower flaps of the external oblique aponeurosis are used to replace formal sutures in effecting union between the conjoined tendon and Poupart's Ligament. The strips should be about one third of an inch wide.

Kirschner (1910).

A plaque of fascia lata cut from the thigh is sewn over the anterior aspect of the suture line of the external oblique. This operation is open to criticism that the fascial plaque is inlaid into the wrong place. It would be better to have it sutured into the canal behind the cord over the closed fascia transversalis.

Bates (1913).

A small two inch incision is made over the site of the internal ring which is exposed through a cut in the external oblique aponeurosis. The sac is then defined and the peritoneum opened by a small incision at its neck. The internal ring and fascia transversalis are then pulled up into the wound with the sac and closed by a purse string suture. The incision in the peritoneum is then closed and finally the incision in the external oblique aponeurosis.

Hull (1913).

Through a small incision, not larger than one inch, the external oblique aponeurosis is exposed and opened for a similar distance. The site of the incision is half an inch medial to the internal ring. The cremaster muscle is identified and its fibres separated to give access to the sac which is defined and pulled into the wound for removal. The neck is then transfixed at as high a level as possible, the sac excised and the stump permitted to retract back again to the abdomen.

Watson (1916).

The cord is dealt with as in a Torek repair and placed high up on the anterior aspect of the exposed internal oblique muscle. It is then anchored there by a few sutures. The external oblique flaps are made to overlap in front of the cord and the wound closed.

Gallie (1921).

Strips of fascia lata are cut from the thigh and interlaced between the conjoined tendon and Poupart's ligament. This has been described in the text.

Stettin (1923).

The canal is opened through the usual approach, and support given by uniting the external oblique aponeurosis behind the cord so as to obliterate the external ring.

Gould

This is in effect a combination of a modified Kirschner and a Classical Gallie repair. The patch of fascia is inlaid posterior to the cord, and the strips are darned behind the cord but anterior to the fascial plaque.

Wangensteen (1936).

A pedicle of the iliotibial tract is used to reinforce the canal by interlacing it between the conjoined tendon and Poupart's ligament. The pedicle remains anchored at its normal lateral attachment. This is an entirely unnecessary refinement of the Gallie method.

Stein (1939).

After herniotomy, a flap of fascia is dissected from the anterior surface of the internal oblique and reflected over the canal to be anchored into position on the shelving edge of Poupart's ligament.

In addition to these operations are others, including Kangaroo tendon, floss silk, dead and living fascial sutures, autogenous and homogenous fascial sutures inserted after the manner of Gallie. Flaps of rectus muscle have been turned from all possible points of the compass and used in every way ingenuity can devise. These are all fundamentally modifications of, or combinations of, one or more of the above principles.

Case Number	Sex	Age	Type of Hernia: Indirect: DATE	Indirect	Indirect: SIDE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Trans-Versalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
1.	M.	44.	30.6.1939.	+	R.					+		+							6	+					12	+	10	+													
2.	F.	40.	13/6/1939.	+	R.						+	+							8	+					12.									+W.							
3.	F.	78	17/6/1939.		L.	+					+		+						120		+	+												+W							
4.	M.	60	12/7/1939	+	R.						+				+				5	+														+51.							
5.	M.	18	11/9/1939.	+	R.						+	+							12	+					9																
6.	M.	62	28/11/1939	+	L.					+			+			+			8	+										+ 51.	+ 51.										
7.	M.	22	13/1/1940.	+	L.					+		+							2	+																					
8.	M.	44.	5/2/1940	+	L.						+	+							5	+																					
9.	M.	68.	8/2/1940.	+	R.					+				+					34			+									+ 51.										
10.	M.	52.	1/4/1940	+	R.					+		+			+				18	+														+51.							
11.	M.	54	8/4/1940		L.	+					+	+							10.	+																					
12.	M.	52.	24/4/1940	+	R						+	+							6	+																					
13.	M.	35	15/5/1940	+	R.						+	+							4	+																					
14.	M.	38.	17/11/1940	+	R.						+	+							14	+																					

NOT FOLLOWED UP AFTER OPERATION.

Case Number	Sex	Age	Type of Hernia: Indirect SIDE		Indirect DATE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haemato-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
15.	M.	40.	R.	+	16/12/1940.						+	+						+	8	+																				
16.	M.	38	R.	+	4/2/1941.						+	+							12	+																				
17.	M.	46	R.	+	4/2/1941.					+		+				+			14	+										+									
18.	M.	35	R.	+	4/2/1941.						+	+							9	+																			
19.	M	41.	L	+	13/2/1941.						+	+							4	+																			
20.	M.	40.	R	+	24/2/1941.				+			+							2	+																			
21.	M.	42.	L	+	2/3/1941.						+	+						+	8	+																			
22	M.	51.	L	+	8/3/1941						+	+						+	14	+										+51.	+								
23	M.	46.	R	+	8/3/1941					+		+							8.	+														+51.					
24.	M.	39.	R.	+	8/3/1941.						+	+							10.	+																			
25.	M	54	R.		18/3/1941	+		+			+			+					31.	+																			
26.	M.	44	L.		29/3/1941.	+		+			+	+							19	+																			
27.	M	32.	R.	+	13/5/1941.						+	+							8	+																			
28.	M.	36.	R	+	20/5/1941					+		+							2.	+																			

NOT FOLLOWED UP AFTER OPERATION.

NOT FOLLOWED UP AFTER OPERATION.

Case Number	Sex	Age	Type of Hernia: Indirect: Side	Indirect	Indirect: Date	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
29	M.	40.	R	+	27/5/1941						+	+							9	+																					
30.	M.	58	L		3/6/1941	+					+	+							24.	+											+ M.												
31.	M.	27.	R.	+	10/6/1941.					+		+							3.			+																				
32.	M.	34.	R.	+	17/6/1941.						+	+							17.	+																							
33.	M.	38	R.	+	1/7/1941.						+	+							10	+																							
34.	M.	39	L.	+	8/7/1941.					+		+							4.	+																							
35.	M.	44.	R.	+	23/7/1941.						+	+							15	+																							
36.	M.	42.	R	+	6/8/1941.						+	+							7.	+											+ 51.												
37.	M.	54.			20/8/1941.	+			+		+	+						+	20.	+											+ 51.												
38.	M.	2.	R.	+	27/8/1941.						+	+							4			+																				
39.	M.	48.	R.	+	27/8/1941.				+			+							10.		+																						
40.	M.	36.	R	+	27/8/1941.						+	+							7.	+																							
41.	M.	30.	L.	+	11/9/1941.						+	+							3.			+																				
42.	M.	38.	R		22/9/1941.	+					+	+							8.	+																							

NOT FOLLOWED UP AFTER OPERATION.

NOT FOLLOWED UP AFTER OPERATION.

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haemat-oma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
43.	M.	43.	R	+ REC.	22/9/1941.						+	+						+	9		+																			
44.	M.	2.	R.	+	22/9/1941.						+	+							6			+																			
45.	M.	48	R		3/10/1941	+					+	+							10	+																					
46	M.	42	R	+ REC.	3/10/1941.					+		+						+	6	+																					
47.	M.	1½	R	+	7/10/1941.						+	+							?			+																			
48	M.	54	R.	+ REC.	14/10/1941.						+	+							?	+														+ 51.							
49.	M.	52	L	+	4/11/1941.						?	+							?	+																					
50.	F.	47.	L	+	26/11/1941				+			+							2	+																					
51.	M.	44	L		30/12/1941.	+		+			+	+							YEARS.	+																					
52.	M.	44	L	+	12/12/1941.						+	+							12	+																					
53.	M	42	R.	+	16/12/1941.					+		+							9	+																					
54.	M.	39.	L	+	20/1/1942.						+	+							8	+																					
55	M.	41.	R	+	20/1/1942.						+		+						16.	+																					
56.	F.	39	L	+	23/1/1942						+	+							20	+																					

NOT FOLLOWED UP AFTER OPERATION.

NOT FOLLOWED UP AFTER OPERATION.

Case Number	Sex	Age	Type of Hernia: Indirect: DATE	Indirect	Indirect: SIDE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haemat-oma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
57.	M.	41.	27/1/1942	+	R.						+	+						+	?	+																				
58.	M.	29.	30/1/1942	+	L					+		+							15.	+																				
59	M	31	30/1/1942	+	R.						+	+							12		+																			
60.	M.	41.	5/1/1942	+	R.						?	+							9		+														+ 51.						
61.	M.	32	13/1/1942	+	L					+		+							?		+																			
62.	M.	58	19/1/1942	+	L						+		+					+	22.		+																			
63	M.	41.	19/1/1942	+	R					+	+	+			+				3.		+																			
64.	M.	50	24/2/1942	+	R						+	+							8.		+									+ 51.											
65.	F.	48	3/2/1942.			+		+			+	+							16.		+																			
66.	M.	50	10/2/1942	+				+			+	+							12		+																			
67	M.	41.	10/2/1942				+	+			+	+						+	14		+													+ 51.						
68.	M.	45.	10/2/1942	+	L.						+	+			+				6		+																			
69.	M.	40	17/2/1942	+	L				+			+							4		+																			
70.	M	38	29/3/1942				+	+				+							20.		+																			

NOT FOLLOWED UP AFTER OPERATION.

NOT FOLLOWED UP AFTER OPERATION.

Case Number	Sex	Age	Type of Hernia: Indirect SIDE		Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Rectus Sheath Trans-Versalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
71.	M.	53.	R.L.	+	3/3/1942.			+			+	+							YEARS.		+																				
72.	M.	41.	L.	+	6/3/1942						+	+							10.		+																				
NOT FOLLOWED UP AFTER OPERATION.																																									
73	M	45	L	+	25/5/1942						+								4	+					24																
74	M	71	R	+	28/7/1942						+							+	?		+				22						+51.										
75	M	62	R	+	29/12/1942						+				+				6	+					17																
76	M	58	L	+	13/10/1942						+								10		+				19																
77	M	67	R		8/12/1942	+					+								17		+				18						+			+ W.							
78	M	47	R	+	1/6/1942					+									?	+					23																
SMALL DIRECT SAC DEVELOPED ON LEFT SIDE ONE YEAR AFTER OPERATION.																																									
79	M	14	R	+	1/6/1942						+								6	+					23																
80	M	45	L	+	29/9/1942					+									4		+				20																
81	M	48	R	+	27/10/1942						+								4		+				19						+										
82	M.	58	R		16/11/1942.		+				+								11		+				19											+ 51.					
83	M	58	R	+	20/7/1942						+								7		+				22																
84	M	48	L	+	16/11/1942					+									6		+				NOT TRACED.																

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct DIFFUSE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
85	M	34	L	+	7/9/1942						+									?		+				20																	
86	M	34	R	+	22/6/1942							+								10	+					23																	
87	M	33	L	+	8/4/1942							+								9	+					25																	+SI.
88	M	51	R		27/11/1942		+					+							+	?		+				18	R.	?	+													+SI.	
89	M	14	R	+	5/8/1942							+								5		+				21																	
90	M	46	L		15/9/1942		+					+								18		+				19																	
434. 90	M	46	R	+	15/9/1942							+								4		+				19																	
91	M	57	R	+	17/6/1942					+										?		+				24						+SI.											
92	M	18	L	+	17/8/1942							+								9		+				22																	
93	M	66	R	+	29/9/1942						+									3	+					21							+SI.										
94	M	55	L	+	8/6/1942						?	?								3		+				24																	
95	F	28	L	+	17/8/1942						+									2		+				21																	
96	M	18	R	+	3/10/1942							+								7		+				19																	
97	M	51	R	+	28/12/1942							+								?	+					18															+	+SI.	+

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct DIFFUSE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
98	M	42	R	+	23/6/1942							+								15	+					24																	
99	M	34	L	+	26/9/1942							+								9		+				26																	
100	M	41	R	+	19/7/1942							+								?		+				23																	
101	F	43	R	+	1/9/1942						+									3		+				21																	
102	M	51	L		9/10/1942		+		+			+								?		+				20																	
405 102	M	51	R		9/10/1942		+		+			+								?		+				20																	
103	F	?	R	+	19/7/1943							+								5		+				13																	
104	M	48	L	+	3/9/1943						+									4	+					12						+M.											
105	M	61	L	+	29/9/1942					+										2	+					21																	
106	F	63	R	+	20/8/1943							+								17		+				16																	
107	M	34	R		1/3/1943	+						+								?	+					21																	
108	M	38	L	+	5/10/1943							+								?	+					14																	
109	M	44	L	+	23/4/1943							+								17		+				14					SI+.												
110	M	42	R	+	3/7/1943						+									9	+					12															+ SI.			

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
111	F	29	R	+	15/6/1943							+								7	+					13															+ 51.		
112	M	27	L	+	6/10/1943						+									8		+				14																	
113	M	22	L	+	30/4/1943							+								12		+				14																	
114	M	45	L	+	14/5/1943							+							+	34		+				13																	
115	M	12	L	+	12/4/1943							+								?	+					NOT TRACED.																	
116	M	57	R		2/4/1943	+						+								6		+				14																+	
117	M	50	L	+	23/11/1943						+									3		+				16																	
118	M	60	L		24/8/1943	+						+								?		+				15														+			
119	M	28	R	+	9/8/1943							+								7	+					16																	
120	M	63	L	+	10/8/1943							+								6		+				NOT TRACED							+									
121	F	53	R	+	4/8/1943						+									2		+				15																	
122	M	47	R	+	11/5/1943							+								4		+				NOT TRACED																	
123	M	55	R	+	5/8/1943							+								7		+				15								+								
124	F	42	R	+	26/4/1943							+								12		+				14																	

EARLY RIGHT IND. PRESENT 6: 5: 45.

SMALL RIGHT DIRECT DEVELOPED FOUR MONTHS AFTER OPERATION.

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocoele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Rectus Sheath Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe/Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
125	M	49	L	+	9/4/1943					+		+							4		+				14	R.	6/12	+														
126	M	58	L		6/4/1943		+				+	+			+				12		+				14																	
127	M	18	L	+	8/1/1943						+	+							?	+					17					+SI.												
128	M	48	L	+	27/7/1943						+	+							6		+				12																	
129	M	49	L	+	9/4/1943						+	+							3		+				14																	
130	M	35	R		29/6/1943		+			+		+							8		+				13																	
131	M	59	R	+	3/9/1943				+			+				+			18	+					12																	
132	M	60	R	+	13/8/1943						+	+							9		+				16																	
133	M	34	R		22/7/1943	+					+	+							4		+				14											+SI.						
134	M	62	R	+	2/4/1943						+	+						+	10		+				13															+	+	
135	F	23	R	+	29/4/1943					+		+			+				12	+					18																	
136	M	53	L	+	29/1/1943						+	+							7		+				14																	
134	M	48	L		9/2/1943	+					+	+							5		+				16																	
138	M	49	R	+	16/4/1943						+	+							14		+				14																	

Case Number	Sex	Age	Type of Hernia: Indirect SIDE		Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Round Trans-versalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
139	M	24	R	+	16/7/1943					+		+							9		+				12																
140	M	54	R	+	19/5/1943						+	+						+	15		+				12	R	3/12	+			+										+
141	M	24	R	+	23/6/1943						+	+							?		+				17																
142	M	76	R	+	18/10/1943						+	+						+	6		+				13																
143	M	41	R	+	27/7/1943	ORIGINALLY OPERATED ON IN 1932. RECURRED 3/12 AGO.					+	+							2		+				12	R	?	+													
144	F	35	L	+	23/11/1943						+	+							10	+					17						+										
145	M	60	L	+	27/4/1943						+	+						+	?		+				14																
146	M	41	R	+	14/6/1943						+	+							15		+				17														+SI.	+M.	
147	M	54	R	+	11/5/1943			+ ALSO 15.5.			+	+							11		+				14																
148	F	22	L	+	23/7/1943						+	+							10		+				12						+								+SI.		
149	M	55	R	+	12/2/1943					+		+							12		+				20					+SI.										
150	M	32	L		6/4/1943		+				+	+							2		+				15																
151	M	68	L	+	24/2/1943						+	+							8		+				17																
152	M	64	L	+	3/2/1943						+	+							17		+				14																

RIGHT FEMORAL AND RIGHT DIRECT INGUINAL DEVELOPED SINCE OPERATION.

Case Number	Sex	Age	Type of Hernia: Indirect SIDE.	Indirect	Indirect DATE	Direct DIFFUSE.	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haemat-oma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
153	M	34	L	+	5/1/1943						+?		+							?	+					18										+51.									
154	M	54	L		26/5/1943		+	SEE ALSO CASE 140.				+	+						+	15	+					12	R.	3/12	+																	
155	M	64	L	+	2/6/1943							+	+							15		+				13	R	8/12		+																
156	M	49	R	+	21/9/1943							+	+							6		+				14																				
157	F	39	R	+	19/4/1943							+	+							8		+				15																				
158	M	54	R	+	13/1/1943						+		+							3	+					18																				
159	M	41	L		12/2/1943		+					+	+						+			+				21						+														
160	M	45	L		12/7/43 1943		+					+	+									+				12																				
161	M	47	R	+	6/12/1943							+	+												+	12								+ Wound											
162	M	71	R	+	20/10/1943							+	+						+			+				13								+ 51.											
163	M	40	R	+	7/12/1943							+	+												+	12																				
164	M	46	R	+	7/12/1943						+		+												+	12																				
165	M	39	L		8/12/1943		+					+	+												+	12																				
166	M	41	L	+	7/12/1943							+	+												+	12																				

Case Number	Sex	Age	Type of Hernia: Indirect SIDE		Indirect DATE	Direct DIFFUSE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Rectus Tendon Vesalii	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
167	M	51	R	+	7/12/1943							+	+							12					+	12	/															
168	F	60	R	+	23/8/1943							+	+							15				+		15	/							WOUND +								
169	M	63	R		10/5/1943		+					+	+			+				1				+		1	R		+						+							
170	M	63	R	+	2/9/1943					RECURRENT (169)		+			+					4 HOURS				+		16	/													+			
171	F	46	R	+	22/10/1943							+	+				+			15		+				20	/															
172	F	48	R	+	22/10/1943						+		+							9		+				14	/															
173	M	41	R	+	9/11/1943							+	+							14		+				13	/															
174	M	45	R	+	9/11/1943							+	+						+	?					+	13	/							WOUND +	+						
175	M	16	L	+	9/11/1943							+	+							?		+				13	/															
176	M	40	R	+	19/4/1943							+	+							7					+	13	/															
177	M	48	L	+	23/11/1943							+	+							10					+	13	/							SMALL HYDROCELE			MIL.				
178	M	40	R	+	20/12/1943					+			+							4					+		/															
179	M	63	L		23/10/1943	+						+	+							?		+				14	/															
180	M	73	R	+	5/11/1943							+	+						+	24					+	15	/															

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Recrudescence, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haemat-oma Scrotum	Orchitis	Sepsis Deep Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue	
			SIDE		DATE DIFFUSE																																						
181	M	39	R	+	2/11/1943					+	+				+			10					+	13																			
182	F	48	R	+	22/10/1943				+		+						+	4		+				13						+													
183	M	54	R		5/11/1943	+				+	+							?					+	13																		
184	F	40	R	+	6/5/1942	RECURRENT. ORIGINAL. OPERATION 24/6/1941.		+			+							3		+				14																			
185	M	60	R	+	4/1/1942					+	+			+				7		+																				+		
186	M	44	R	+	6/4/1942					+	+							9	+					24																		SMALL LEFT DIRECT PRESEN A YEAR.
187	M	61	R	+	4/5/1942					+	+							6		+				26	R.	14.	+			+										+		
188	M	64	R	+	11/5/1942					+	+							14		+				36																		
189	M	22	R		13/4/1942	+			+S		+							4		+				26																	+	
190	M	32	L		25/4/1942	+			+S		+							8		+				24	R	6	+			+												
191	M	19	L		9/5/1942	+			+S		+							8				+		25						+												
192	M	19	R		9/5/1942		+		+S		+							2		+				25																		
193	M	30	L		8/5/1942		+		+S		+							2		+				27																		
194	M	21	R		13/5/1942		+		+S		+							1		+																						

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
195	M	24	R	+	30/5/1942						+S	+							?			+			27								WOUND. +								
196	M	35	R	+	27/5/1942					+S		+							2	+					25															+		
197	M	23	R	+	10/6/1942						+S	+							4			+			24																	
198	M	30	L	+	10/6/1942						+S	+							?	+					24	R	3		+											+		+
199	M	32	R		8/4/1942		+			+S		+							3		+				NOT TRACED.																	
200	M	23	L		11/7/1942		+				+S	+							?	+																					
201	M	19	R	+	8/7/1942					+S		+							2			+			24	R	4	+														
202	M	35	L	+	11/7/1942					+S		+							3		+				25																	
203	M	45	L	+	24/7/1942						+S	+	+						?		+				23																	
204	M	27	R		3/8/1942	+					+S	+							15		+				22																	
205	M	26	L	+	11/8/1942						+S	+							9			+			22																	
206	M	43	R		10/8/1942		+			+S		+							2		+				22								WOUND. +								
207	M	24	R		26/8/1942		+		+S			+							1		+				22																	
208	M	25	L	+	4/9/1942						+S	+							?		+				14	R	3	+													+	

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE.	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
209	M.	27	L		12/9/1942	+					+S	+						+	10		+				15	R	6	+	SEE	ALSO	CASE	No 214.							+		
210	M	28	R		30/9/1942	+					+S	+							?		+				21														+		
211	M	24	L	+	30/9/1942					+S		+							2		+																				
212	M	32	R	+	5/10/1942	+		+			+S	+							8				+		21							+									
213	M	35	R	+	5/10/1942	+		+			+S	+							7		+																				
214	M	34	R	+	6/10/1942					+S		+							3		+				20																
215	M	46	R	+	14/10/1942					+S		+							1	+					20																
216	M	40	L	+	17/10/1942					+S		+							4		+				20																
217	M	27	L	+	24/10/1942						+S	+							8				+		20												+51.				+	
218	M	39	R	+	28/10/1942					+S		+							2		+				20																
219	M	19	R	+	3/11/1942						+S	+							?			+			17	R	5	+			+										
220	M	26	L	+	3/6/1943						+S	+			+				?			+			24																
221	M	24	R	+	24/6/1943						+S	+							4				+																		
222	M	30	R	+	3/7/1943.					+S		+							2				+																		

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Recurrence, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
223	M	18	L	+	5/7/1943						+S	+							6			+									+											
224	M	25	L	+	6/7/1943						+S	+							9				+								+											
225	M	28	L	+	29/7/1943					+S		+							3				+											+								
226	M	24	L	+	5/8/1943						+S	+							8				+																			
227	M	20	R	+	5/8/1943						+S	+							10			+																				
228	M	40	R	+	28/8/1943						+S	+							10				+		21	R			+				+									
229	M	24	R	+	18/9/1943						+S	+							7				+																			
230	M	?	R	+	22/9/1943						+S	+							4				+		8									WOUND +								
231	M	?	R	+	22/9/1943						+S	+							9			+			8																	
232	M	26	R	+	23/10/1943						+S	+							7				+																			
233	M	28	L	+	13/11/1943						+S	+				+			6				+																			
234	M	19	R	+	9/11/1943						+S	+							6			+			6																	
235	M	19	L	+	4/12/1943						+S	+							2				+		18											+						
236	M	21	L	+	6/1/1944						+S	+							9				+																			

Case Number	Sex	Age	Type of Hernia: Indirect SIDE		Indirect DATE	Direct DIFFUSE		Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
237	M	18	R	+	1/4/1942							+	+							16		+				27																
238	M	39	R	+	12/5/1942							+	+							8	+					29																
239	M	39	L		22/5/1943	+						+	+							8	+					29	R	8	+		+	51.										
240	M	40	R		4/1/1943		+					+	+							9				+		23																
241	M	41	L		7/1/1943		+					+	+							12		+				12																
242	M	42	R	+	7/1/1944							+	+							8					+	12																
243	M	45	L	+	10/1/1944							+	+						+	7					+	12						+										18/1/45 RIGHT IND. ING. HERNIA DEVELOPED 3/12 AGO.
244	M	52	R	+	11/1/1944							+	+						+	9		+				12						+										
245	M	46	L		11/1/1944			+				+	+							8		+				16																
246	M	45	L	+	14/1/1944							+	+							6				+		15																
247	M	~~52~~ 53	L		21/1/1944		+	SEE ALSO No 251.				+	+							8					+	12																
248	M	52	R		26/1/1944			+				+S	+	RECURRED FOR 3rd TIME					+	9					+																	
249	M	56	L	+	29/1/1944							+	+						+	11					+	15						+										
250	F	23	R	+	3/2/1944							+	+							5					+							+										

Case Number	Sex	Age	Type of Hernia: Indirect: Side	Indirect	Indirect: Date	Direct: Diffuse	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Discharge, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse of Lung	Haematoma Scrotum	Orchitis	Sepsis Drain Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
251	M.	52	R	+	25/1/1944.			SEE ALSO No. 247.				+	+							8					+	12																		
252	F	13	R	+	18/2/44							+	+										+			12																		
253	M	34	R	+	19/2/1944							+	+ RECURRED 4 YRS AGO												+	13																		
254	M	28	L		21/2/1944		+					+	+S												+	15																		
255	M	27	R	+	26/2/1944							+	+S												+	15																		
256	M	56	R	+	29/2/1944						+		+												+	12					+ Cleared within 14 DAYS.												
257	M	35	R	+	6/2/1944						+		+S												+	14																		
258	M	52	R	+	7/3/1944						+		+												+	12												LEFT IND. ING. HERNIA DEVELOPED 2/12 AGO.					
259	M	34	L	+	19/2/1944							+	+										+			13																		
260	M	33	R	+	9/3/1944							+	+S												+	15																		
396. 261	M	45			9/3/1944				+			+	+S												++																		
262	M	18	L	+	9/3/1944						+		+S					+					+																					
263	M	32	R		16/3/1944	+						+	+S												+																		
264	M	24	R	+	16/3/1944							+	+S										+																					

Case Number	Sex	Age	Type of Hernia: Indirect SIDE		Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascial Trans-Versalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe, Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
265	M	35	R	+	17/3/1944						+	+						+	8					+	12	/					+										
266	M	59	R	+	21/3/1944						+	+			+				4					+	14					Cleared in 10 DAYS. + SI.												
264	M	17	R	+	21/3/1944			+			+	+							10					+	15																
418 ~~267~~	M	17	L	+	21/3/1944			+		+		+							2			+			15																
268	M	36	L	+	21/3/1944						+	+							9					+	12	/															
269	M	37	R	+	21/3/1944					+		+			+				7					+	13																
270	F	22	R	+	22/3/1944						+	+			CYST OF CANAL OF NÜCK.				8			+			13																
271	M	53	L		22/3/1944		+	+			+	+		Recurrent after Fossa.					11					+	13	R	6	+													
419 ~~277~~	M	53	R		22/3/1944	+		+	+			+							14					+	14																
272	M	59	R	+	24/3/1944					+		+							9					+	13																
273	M	25	R	+	25/3/1944						+S	+			+				3					+		/	/														
274	M	28	R		1/4/1944		+				+S	+		SEE ALSO N° 209			+		8					+	12	R	ao femoral.													
275	M	21	R	+	7/4/1944						+	+							9			+			12																
276	M	54	L	+	7/4/1944						+	+							2					+	13																

Case Number	Sex	Age	Type of Hernia: Indirect: SIDE	Indirect: DATE	Direct: DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Rectus and Trans-Versalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
277	M	55	R +	11/4/1944						+	+							8					+	13																
278	M	30	R +	17/4/1944						+S	+			LEFT FEMORAL ALSO PRESENT.				10			+			12																		
279	M	61	R +	13/4/1944					+		+							2					+	12																	
280	M	33	R	24/4/1944		+				+S	+							4					+	13																	
281	F	46	R +	24/4/1944				+			+			LEFT FEMORAL ALSO PRESENT.				9			+			/																		
282	M	?	R +	28/4/1944					+		+							7			+			12																	
283	M	18	R +	29/4/1944					+S		+							11			+			12	R	4	+														
284	M	45	R	29/4/1944	+		+			+S	+							12					+	/									+								
420 ~~284~~	M	45	L	29/4/1944		+				+S	+							9					+	/									+								
285	M	35	R +	2/5/1944			+			+	+							10					+	13					+ Clear in 18 DAYS.											
421 ~~285~~	M	35	L	2/5/1944		+				+	+							2					+	13																	
286	M	52	R +	5/5/1944				+			+							8					+	12																	
287	M	26	L +	8/5/1944						+S	+							7					+	/						+										
288	M	58	R	8/5/1944		+	ALSO 289.			+	+							9	+				◈	13	R	5	+														

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Type of Recurrence: Interval Before Onset Recurrence	Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
289	M	58	L	8/5/1944	+		ALSO 288			+	+							12					+	13						+										
290	M	49	R	9/5/1944	+		+			+	+							8					+	12																
422 ~~290~~	M	49	L	9/5/1944	+		+			+	+							2					+	12																
291	F	49	R	10/5/1944	+			+			+						+	9					+	12						+										
292	M	62	L	23/5/1944	+				+		+						+	6					+	12									WOUND. +							
293	M	27	L	29/2/1944	+		+			+	+S						+	9					+	15								+								
294	M	27	R	24/5/1944	+					+	+S						+	3					+	12								+								
295	M	43	L	30/5/1944		+				+	+							8					+	12																
296	M	42	L +	6/6/1944					+		+							2					+	12																
297	M	46	L +	6/6/1944						+	+			RIGHT FEMORAL ALSO PRESENT.				6			+			12																
298	M	42	R +	23/6/1944						+	+							1					+	12																
299	M	34	R +	23/6/1944					+		+							9					+	12						+										
300	M	30	L +	26/6/1944						+	+S							7					+																	
301.	M	32	L +	3/7/1944						+	+							12					+	12																

Case Number	Sex	Age	Type of Hernia: Indirect SIDE		Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Trans-Versalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Type of Recurrence: Interval Before Onset Recurrence	Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
302	F	39	L	+	3/7/1944						+	+						8					+	15																
303	M	30	R	+	8/7/1944			+			+S	+						8					+	12																
423 ~~303~~	M	30	L	+	8/7/1944						+S	+						6					+	12																
304	F	28	R	+	11/7/1944						+	+				+		9					+	12																
305	M	38	R	+	11/7/1944						+	+						2					+	13																
306	M	56	R	+	11/7/1944			ALSO 312			+		+					8					+	13																
307	M	23	L	+	15/7/1944						+	+S						9			+			12									WOUND. +							
308	F	32	R	+	21/7/1944					+		+						?					+	13																
309	M	29	R	+	19/7/1944				+S			+						?			+			12																
310	F	48	R	+	25/7/1944						+	+						6					+	/					DIED 8TH DAY OF AN ACUTE LIVER ATROPHY.													
311	M	31	R	+	25/7/1944					+		+						?					+	12																
312	M	56	L	+	18/7/1944			ALSO 306			+	+						14					+	10																
313	M	3/12	L	+	6/8/1944						+		+					2/12			+			12																
314	M.	57	L	+	11/8/1944						+	+					+	10					+	9																

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Resumption, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haemat-oma Scrotum	Orchitis	Sepsis Pelvic Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
315	F	38	R	+	19/8/1944			+			+	+			RIGHT FEMORAL ALSO PRESENT.				4				+	9						+											
424 (315)	F	38	L		19/8/1944		+				+	+							9				+	9																
316	M	40	L	+	19/8/1944						+	+							7				+	12																
317	M	43	L	+	19/8/1944					+?	+?	+			+				2				+	12																
318	M	26	L	+	23/8/1944						+	+				+			11			+		12																
319	M	32	R	+	18/9/1944						+S	+							6				+									VERY SMALL +							
320	M	52	R		18/9/1944	+					+	+							7				+	11																
425 (320)	M	52	L		18/9/1944.	+		+				+							3				+	11																
321	M	36	R	+	18/9/1944					+S		+							1			+		12					Sl.+	+										
322	M	56	R	+	12/9/1944				+			+						+	2				+	11																
323	M	32	R		14/9/1944		+				+S	+							?				+	12																
324	M	43	R		23/9/1944		+				+	+							9				+	12							+		WOUND. +							
325	M	?	R	+	18/9/1944						+	+							4				+	11																
428 (325)	M	?	L	+	18/9/1944.			+			+	+							1				+	11																

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect DIFFUSE	Direct DATE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Sturm's of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haemat-oma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
326	M	46	R		4/10/1944	+				+	+			+				9					+	11																	
327	M	55	R	+	4/10/1944					+	+						+	8					+																		
328	M	34	L	+	4/10/1944				+		+							6					+	9																	
329	M	29	R	+	4/10/1944					+	+							12				+		12																	
330	M	40	R		17/10/1944	+				+	+							2					+	12																	
331	M	19	R	+	18/10/1944				+		+							5				+																		
332	M	26	R	+	18/10/1944				+		+							9			+			12																	
333	M	24	R	+	18/10/1944		ALSO 340.			+	+							11				+		10																	
334	M	34	R	+	18/10/1944					+	+				+			9					+	8																	
335	M	34	R	+	21/10/1944					+	+	RECURRED THREE TIMES BEFORE THIS OPERATION BY SELF.						9					+	10																	
336	M	40	L	+	6/11/1944					+	+							2				+																		
337	M	32	R		10/11/1944	+	ALSO 341.			+	+							7					+																		
338	M	52	R	+	10/11/1944				+		+							4					+	10																	
339	M	19	R	+	28/11/1944					+	+ EN BIS SAC.							4			+																				

Case Number	Sex	Age	Type of Hernia: Indirect SIDE		Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-admission, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Other Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
340	M	24	L	+	18/10/1944			SEE ALSO 333			+S	+				+			2			+																		
341	M	32	L	+	17/11/1944			SEE ALSO 337			+	1	+						6					+									WOUND +							
342	M	25	L	+	9/12/1944						+S	+							5			+																		
343	M	30	R	+	9/12/1944			+			+S	+					+		3					+																
344	M	30	L	+	18/12/1944						+S	+					+		5					+																
345	M	33	R		9/12/1944	+					+S		+						8					+						+51										
346	F	34	R	+	6/12/1944					+		+							2					+																
347	M	57	L	+	6/12/1944						+S	+							6					+																
348	M	45	R	+	6/12/1944						+S	+				+			8					+	9					+										
349	M	21	R	+	6/12/1944					+S		+							4				+		9															
350	M	24	R	+	6/12/1944					+S		+							4					+																
351	M	27	R	+	30/9/1942						+S	+					+		?			+			9	/														TESTIS IN SCROTUM BUT SUBNORMAL IN SIZE.
352	M	33	R	+	8/10/1942						+S	+					+		?			+			9	/														OP. FOR DESCENT TESTIS SATISFACTORY.
353	M.	19	L	+	28/12/1942						+S	+					+		?			+			10	/														OP. FOR DESCENT TESTIS SATISFACTORY

Case Number	Sex	Age	Type of Hernia: Indirect Side	Indirect	Indirect Date	Direct Diffuse	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haemat-oma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue	
354	M.	20	L	+	9/11/1943						+S	+					+		?				+		10	/											TESTIS SMALL BUT IN SCROTUM.						
355	M	21	R	+	23/10/1943						+S	+					+		6.				+		9	/											TESTIS NORMAL AND IN SCROTUM.						
356	M	19	L	+	3/11/1943						+S	+					+		9.				+		9	/											TESTIS VERY SMALL IN SCROTUM.						
357	M	20	R	+	6/5/1944						+S	+					+		3						6	/											TESTIS SATISFACTORY.						
359	M	34	R	+	19/2/1944					+		+												+																			
360	M	62	L	+	15/1/1944			+			+	+												+						+													
361	M	62	R		15/1/1944	+		+			+	+												+																			
362	M	50	R	+	9/1/1945			+		+		+												+																			
363	M	50	L	+	9/1/1945			+		+		+												+																			
364	M	26	L	+	12/1/1945						+	+												+											+								
365	M	32	L		29/1/1946		+					+												+																			
366	M	24	L	+	10/2/1944						+	+										+																				
367	M	24	L	+	10/2/1944						+	+										+																				

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Trans-Versalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis in Skin Wound	Late: Hydrocele	varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
368	M	39	R	+	12/2/1946				+			+										+																			
369	M	52	L	+	20/2/1944			+			+	+												+						+											
370	M	52	R	+	20/2/1944			+			+	+												+						+											
371	M	40	L	+	20/2/1944					+		+												+																	
372	F	38	L	+	13/3/1945					+		+												+						+											
373	M	50	R		13/3/1945	+		+			+	+												+																	
374	M	50	L		13/3/1945	+		+			+	+												+																	
375	M	65	L	+	13/3/1945						+	+												+																	
376	M	36	R	+	15/3/1945						+	+											+																		
377	M	30	L		15/3/1945	+						+												+																	
380	M	33	L		19/3/1945	+						+												+						+											
382	M	45	R		21/3/1945					+		+											+																	
383	M	39			21/3/1945		R			+		+												+																	
385	M	21	L	+	26/3/1945						+	+											+																		

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect DATE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
386	M	23	L	+	26/3/1945					+	+			CRURO SCROTAL									+																	
387	M	19	R	+	29/3/1945					+	+			CRURO SCROTAL							+																			
389	F	49	L	+	6/4/1945						+										+																		
390	M	49	R	+	6/4/1945				+		+			RECURRENT FROM ORIGINAL OPERATION 1943 No 122									+																	
391	M	60	L	+	30/3/1945				+		+								+																			
392	M	40	L		13/4/1945	+		+			+												+															
393	M	31	R	+	13/4/1945					+	+										+							+										
394	F	42	L	+	17/4/1945						+										+																		
396	M	45	L		9/3/1944	+ (see also 261)				+	+												+								+							
397	M	47	R	+	18/4/1945				+		+												+															
398	M	45	R	+	18/4/1945					+	+												+															
399	F	35	R	+	18/4/1945		+			+	+										+																	
400	F	35	L	+	18/4/1945		+			+	+										+																	
405	M	51	L		29/4/1942	+	+		+		+			See also 102						+				28															

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Indirect DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
408	M	48	L	+	3/9/1943						+	+								+					18																	
418	M	14	L	+	21/3/1944			+		+		+	SEE ALSO 267											+	15								+								
419	M	53	L		22/3/1944		+				+	+													13																	
420	M	45	L		29/4/1944		+	+			+	+	SEE ALSO 284											+																		
421	M	35	L		2/5/1944	+		+			+	+	SEE ALSO 286											+	13																	
422	M	49	L	+	9/5/1944			+		+		+	SEE ALSO 290											+	12																	
423	M	30	L	+	8/7/1944			+			+	+												+	12																	
424	F	38	L		19/8/1944	+				+		+												+	9																	
425	M	52	L		18/9/1944	+					+	+												+	12																	
428	M	60	R	+	18/9/1944						+	+													9																	
429	M	32	L		6/11/1944	+				+		+												+																	
431	M	38	L		19/12/1944	+					+	+									+									+												
433	M	45	R	+	20/4/1945				+			+												+																	
434	M	46	R		15/9/1942	+				+		+									+				20						+											

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect DATE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Clasical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Transversalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haematoma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varicocele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
435	M	30	L +	21/4/1945						+	+										+									+									
436	M	28	R	21/4/1945	+				+		+											+	+								+									
466	M	18	L +	11/3/1944						+	+					+					+			14															
468	M	24	L +	9/1/1943						+	+					+					+			16						+									
469	M	32	R +	25/4/1945	OPERATED TWICE BEFORE LARGE RECURRENCE											(two layers of skin)					+ +	+ +								+									
470	M	44	L +	26/4/1945					+		+											+	+																
471	M	44	R +	24/4/1945						+	+				+							+	+																
472	M	23	R +	4/5/1945						+	+										+									+									
473	M	56	R	4/5/1945	+ SEE ALSO 241 & 419			+			+								+											+									
474	M	22	L +	6/5/1945						+	+				+						+									+									
475	M	39	R +	6/5/1945						+	+										+									+									
476	M	40	L +	28/8/1943			+		+		+									+				21	R	4 +													
478	M	64	R +	15/5/1945					+		+											+	+																
479	M	46	R +	15/5/1943						+	+											+	+																

Was obliged to work in quarry by sergeant 4 months after op.

each linen stitch anchoring graft at last operation found at present op. to have small pool of pus containing staph. albus on culture graft had not taken

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect	Direct DATE	Direct DIFFUSE	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Closure of Fascia Trans-Versalis	Whole Skin Graft	Time after Operation before Re-examination, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
480	M	58	R	+	15/5/1945 SEE ALSO 288				+			+											+																		
481	M	40	R	+	28/8/1943 SEE ALSO 476					+		+									+				21	R		+													
482	M	18	R	+	17.5.45					+		+			+							+																		
483	M	49	R	+	21.5.45					+		+											+																		
484	M	25	R	+	18.5.45				+			+										+																		
485	M	18	R	+	26.5.45					+		+										+																		
486	M	28	L	+	26.5.45						+	+										+																		
487	M	41	L	+	22.5.45						+	+				+							+																		
488	M	41	L	+	22.5.45					+		+											+																		
489	M	38	R	+	15.6.45						+	+										+																		
5490	M	46	R	+	31.5.45					+		+									+																		
491	M	46	R	+	31.5.45				+			+											+																		
492	M	23	L	+	6.5.45						+	+											+																		
493	M	28	R	+	26.4.45						+	+											+												WOUNDS +						

Case Number	Sex	Age	Type of Hernia: Indirect SIDE	Indirect DATE	Indirect DIFFUSE	Direct	Direct and Indirect	Bilateral	History of Strain: Severe	Moderate	None	Complications: Reducible	Incarcerated	Strangulated	Associated Lesions: Hydrocele	Varicocele	Undescended Testicle	Bronchitis	Duration before Operation, in Months	Type of Operation: Classical Bassini	Fascia	Herniotomy	Herniotomy and Suture of Fascia Trans-Versalis	Whole Skin Graft	Time after Operation before Discharge, in Months	Recurrence	Interval Before Onset Recurrence	Type of Recurrence: Direct	Indirect	MORBIDITY: Early: Wound Sepsis	Bronchitis	Broncho-Pneumonia	Collapse Lobe Lung	Haema-toma Scrotum	Orchitis	Sepsis Thigh Wound	Late: Hydrocele	Varico-cele	Atrophy Testicle	Pain in Scar	Pain in Thigh	Fatigue
H94	M	21.	R	+	1.6.45.				+			+						+						+						+	+											
H95	M	16	L	+	8.6.45.					+		+										+																			
H96	M	41.	R	+	8.6.45.						+	+						+						+							+										
H97	M	47.	R	+	4.6.45.						+	+												+																		
H98	M	51.	L	+	4.6.45.						+	+											+																			
H99	M	60.	L	+	15.6.45.					+		+												+										+								
500	M	39.	R	+	22.6.45.					+		+												+																		